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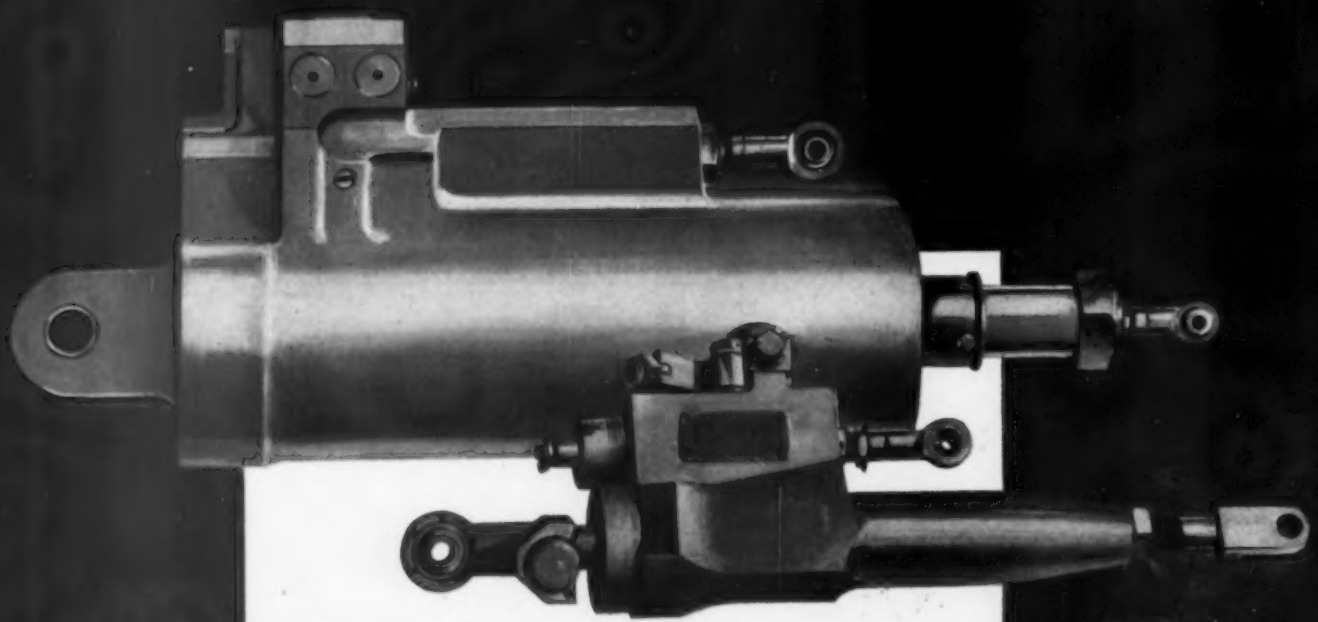

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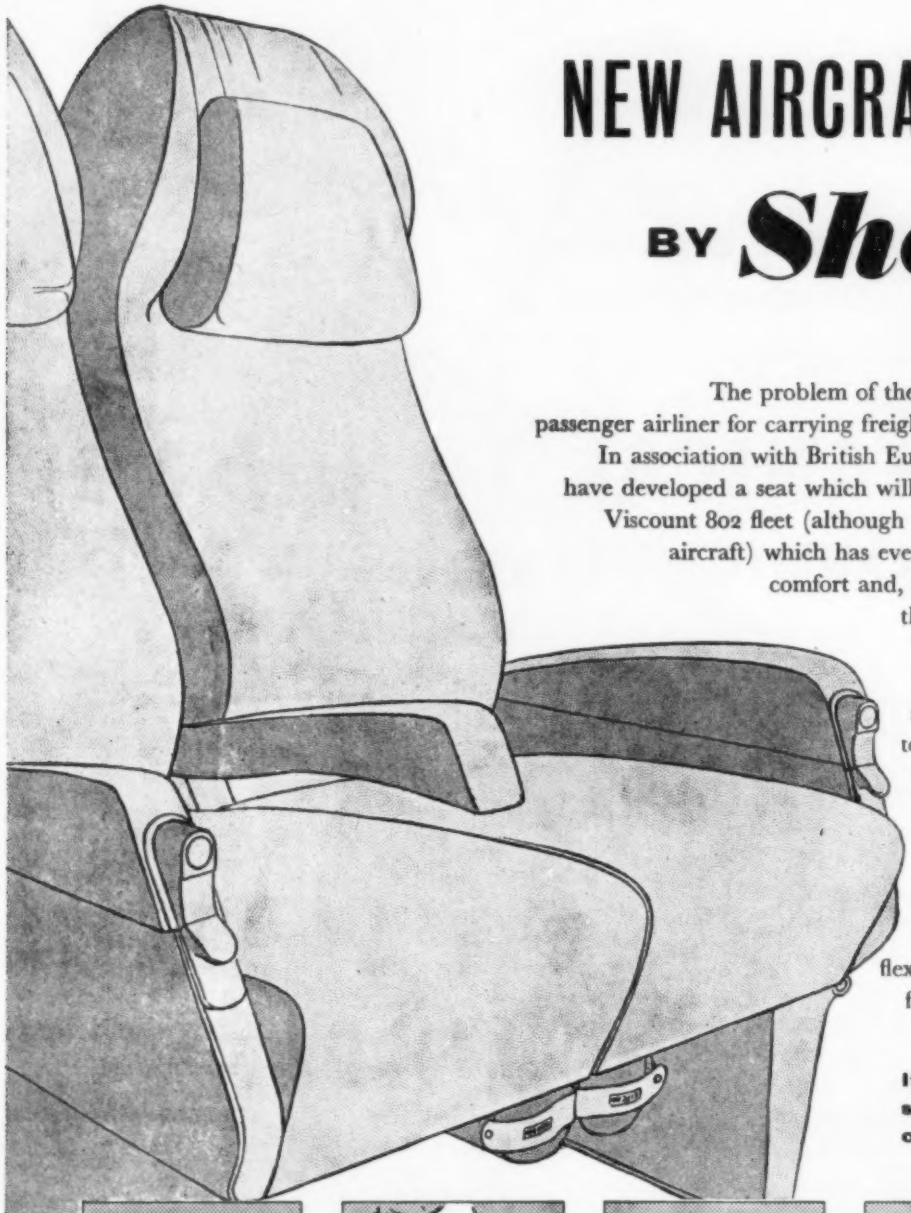

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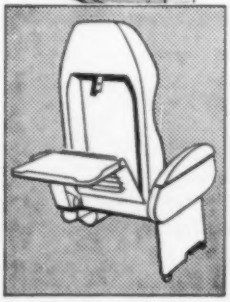

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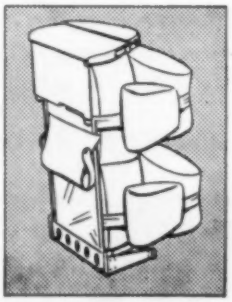

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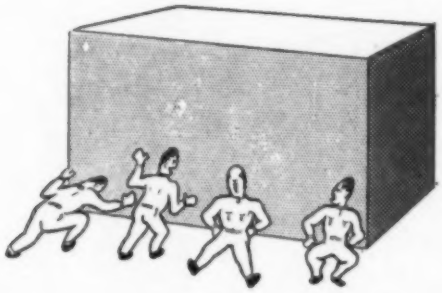

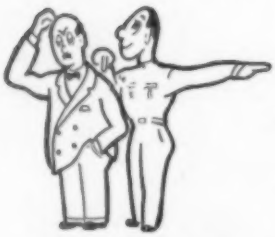

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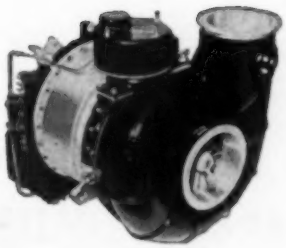

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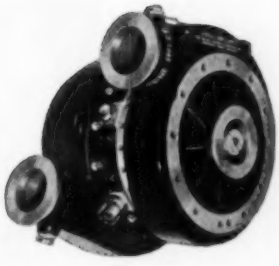

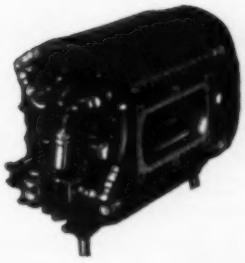

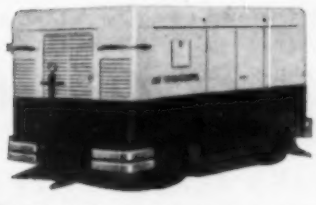

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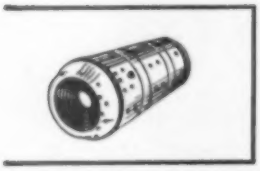

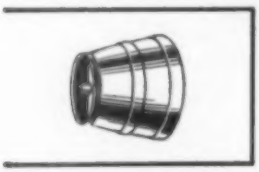

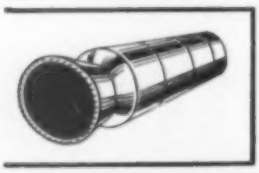

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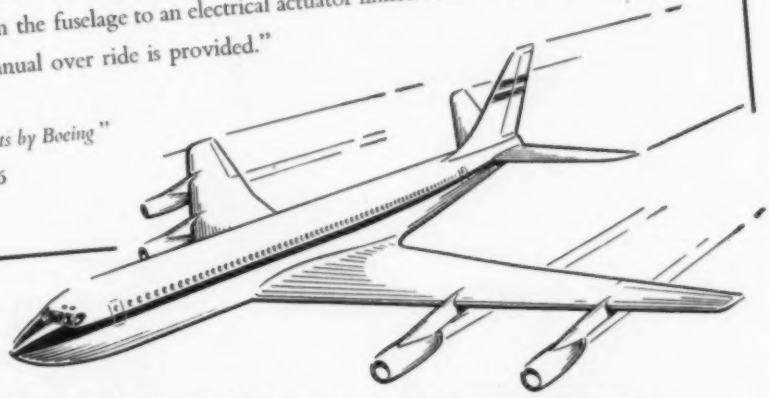
Extract from "Turbojet Transports by Boeing"
The Aeroplane, January 27, 1956



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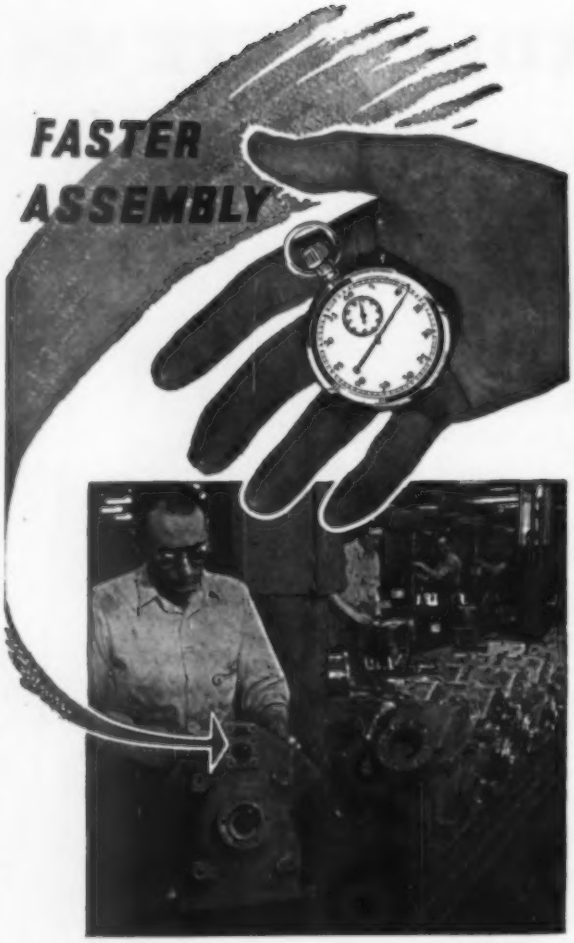

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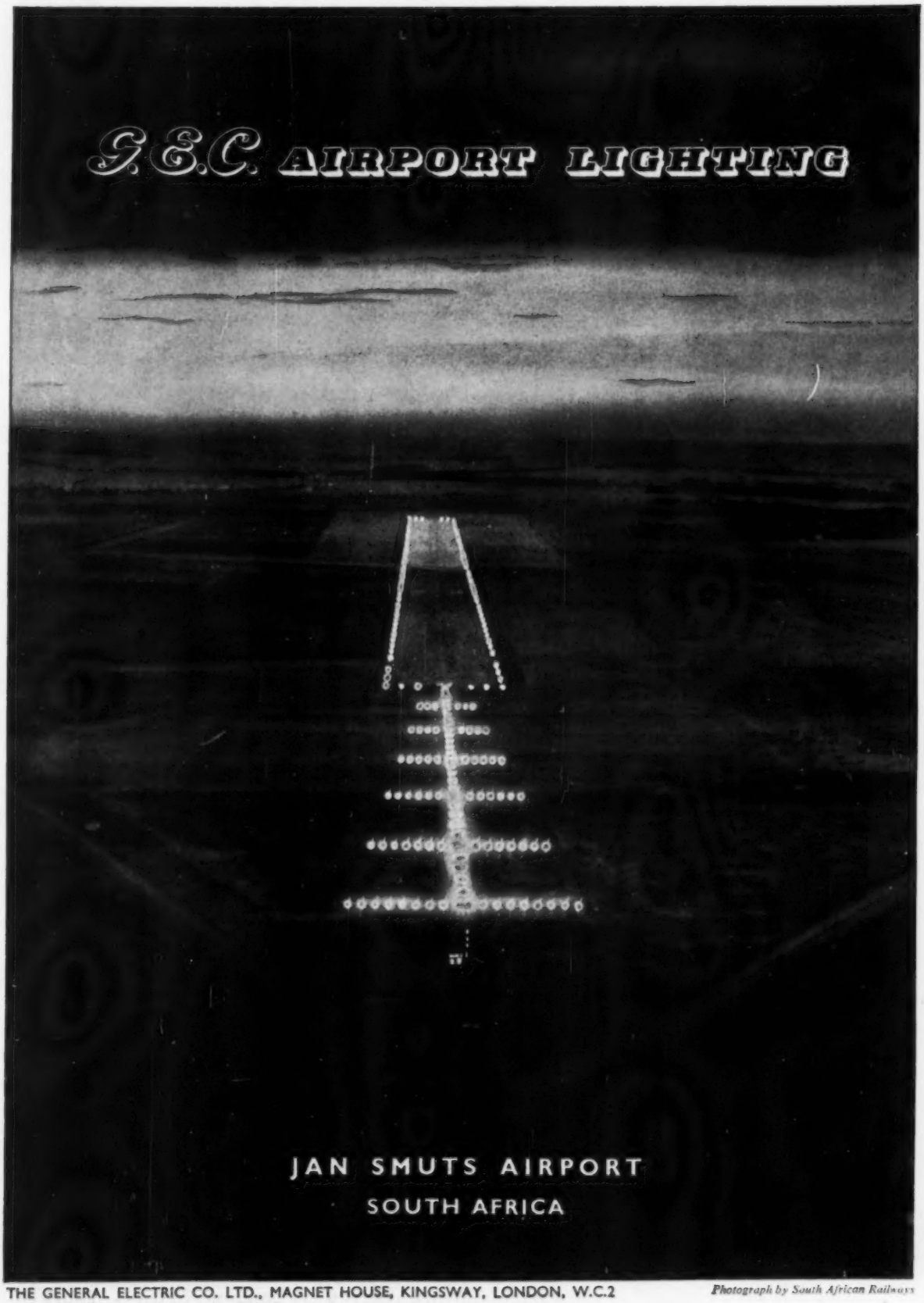

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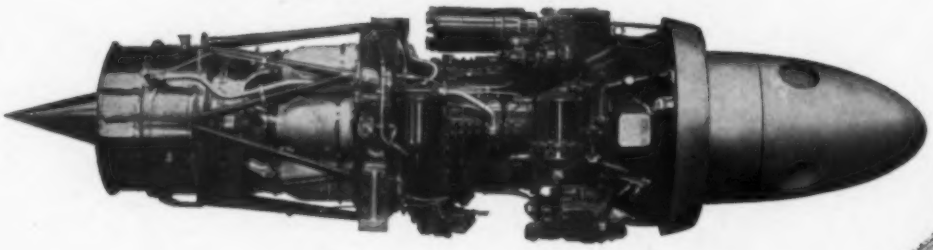

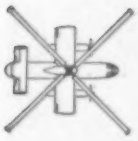

ELAND A Convair 340 aircraft converted to Eland engines will be on demonstration flights in Europe and the U.S. during this year. Another aircraft powered by *Elands* is the Elizabethan, converted for freighter evaluation. Napier *Elands*, fitted with auxiliary compressors for the tip-powered rotor system, will be mounted in Fairey's new large transport helicopter, the Rotodyne.

ORYX Two Napier *Oryx* engines are being mounted in the new Percival P74. Napier worked with Hunting Percival in the development of the *Oryx*, a 750-825 gas h.p. turbo-gas-generator which has been Type Tested at 780 g.p.h. This new Napier power unit eliminates all mechanical transmission.

GAZELLE The *Gazelle* is another Napier engine which is going places. The first helicopters to be powered by *Gazelles* are the Westland 'Wessex' and the twin-rotor Bristol 192. The engine can be mounted in any position, vertically or horizontally and can be directly connected to the rotor head, providing mechanical transmission in its simplest form.

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FLIGHT
and
AIRCRAFT ENGINEER

No 2466 Vol 69 FRIDAY 27 APRIL 1956

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The Tired Pilot

THIS is the time of year when the airlines are drawing in a deep breath in preparation for the heavy exertions of the summer. Without exception the efforts of every operator will be more strenuous than ever, and the question of aircrew fatigue once again comes into prominence. It is a disturbing fact that the majority of British pilots and crews are not entirely happy about flight-time limitations. Cautiously, I.C.A.O. leaves this highly controversial matter to the conscience of each country, and in the absence of international legislation individual governments are charged with reconciling the interests of the pilot and his employer.

The airlines are not whipcracking slave-drivers; nor are pilots always grumbling about the strain and responsibility of their profession. But the Ministry's recent revised legislation on crew fatigue, couched in the terms of stodgy legalese—one pilot said that reading it was guaranteed to induce crew fatigue—was received by the British Air Line Pilots' Association with bitter disappointment and hostility. The pilots' attitude was perhaps over-vehement ("warped thinking," "Alice-in-Wonderland legislation"), since the document was undoubtedly the result of well-intentioned Ministerial study; but its outstanding weakness was the inadequate allowance that was made for the *type* of flying undertaken. The proposed hours of duty, for instance, made no distinction between day and night flying, or between long-haul and short-haul operations. One does not have to be an airline pilot to appreciate that two DC-3 pilots flying a complicated U.K. airways pattern in dirty weather are more tired at the end of 16 hours than two pilots, assisted by a crew of three, flying by long stages to the Far East.

No responsible operator is likely to turn legislative loopholes to his own advantage, but while the opportunity exists for him to do so the pilot's mind will never be fully at rest. In the meantime operators can lighten the load on flight-crews by considerate scheduling, the provision of good rest facilities down the route, and the cutting down of stand-by time and pre-flight duty. And, looking ahead (since the technical load upon aircrews will increase rather than diminish with time) we quote for the attention of designers from G/C. J. A. Newton, chief of I.C.A.O.'s flight branch: "Since the present human design appears fairly static, with little evidence of a new improved model, it would appear that aircraft design must bear the brunt of any [fatigue-reducing] innovations."

Under New Management

WHEN the new B.O.A.C. appointments have settled into the perspective of history it will be seen that they were good ones. Not only because the men concerned, Mr. Gerard d'Erlanger and Sir George Cribbett, were well chosen—both are steeped in British aviation and understand the workings of airline commerce—but also because the Corporation's superstructure was re-modelled in accordance with B.O.A.C.'s increasing responsibilities. No matter how ardent the devotion of one man, the double responsibility of chairman and chief executive—as Sir Miles must have found—is a task for more than one. Mr. Gerard d'Erlanger has Sir George Cribbett's full-time backing as his deputy (confidence in the choice of Mr. d'Erlanger is tempered with regret that his chairmanship is not a full-time one), and probably by the time these words are read the post of chief executive will have been filled from the ranks of B.O.A.C.

The first nettle the new men will have to grasp is the crucial issue of the Corporation's future equipment policy. Should it buy British-engined American jet airliners to maintain its competitive position in the early sixties, or should it wait until the late sixties for a supersonic British airliner? There is no reason to lack confidence in the ability of B.O.A.C.'s new management to make a decision that history will prove was correct.

FROM ALL QUARTERS

Herons by Appointment

THE Queen's Flight has long been the subject of debate. Everyone was agreed that the Royal Vikings were no longer suitable, but opinions differed as to what sort of aircraft should replace them. Some proposed the Britannia on the grounds that nothing but the best would do for Royal travel by air, and there was evidence only very recently (*Flight* for April 13th) that this was being seriously considered. Other critics protested vehemently against any expensive re-equipment, arguing that Royal travel overseas should always—as in the past—be entrusted to the experienced Corporations. The announcement last week that two de Havilland Herons and two Westland S-55 Whirlwinds are to be added to the Queen's Flight should neatly silence the critics on both sides—assuming, that is, that the proposal to order a Britannia is not taken up. The Queen's Flight already has one Heron, delivered last May and flown regularly by the Duke of Edinburgh on his travels up and down the country. The S-55 also has been used regularly by the Royal family.

Ghost Development

AFTER a considerable period of secrecy, it is now permissible to refer to two developments of the de Havilland Ghost turbojet. The Ghost DGt.4 is in production and is probably used in the latest forms of Venom all-weather intercepter. It has a type-tested rating of 5,350 lb thrust, an increase of 500 lb over the standard rating of most of the Ghosts at present in service. Owing to fuel-system re-design, and other changes, it is lighter than its immediate predecessor. A marked increase in the top temperature is permitted by use of a cooled turbine.

The other rating to which we can now refer is the DGt.5. In this project a greater mass-flow, and other changes, would have allowed a rating of 6,000 lb. It was intended for installation in the Comet. We expect to make further reference to these engines in a future issue.

Russian Leaders see the R.A.F.

LAST Monday Marshal Bulganin and Mr. Nikita Kruschev, accompanied by Mr. A. N. Tupolev, the distinguished Soviet aircraft designer, flew from Birmingham to R.A.F. Station Marham in a B.E.A. Viscount to see an impressive flying show by Service aircraft. Hunters, Canberras and Valiants were lined up on the tarmac as the Viscount taxied in, and the visitors watched from the control tower balcony as Marshal Bulganin gave the signal for a mass take-off by 28 Hunters. This was followed by a fly-past of 12 Valiants and 16 Canberra B.6s.

Highlight of the display was the formation aerobatic demonstration by four Hunters of No. 43 Sqn.—the Fighter Command aerobatic team, led by F/L. P. Bairstow. They went through the full range of manœuvres, changing formation frequently the while. The Soviet visitors seemed deeply impressed and Mr. Tupolev commented enthusiastically on the standard of flying and asked many searching questions about the aircraft. An invitation to attend the Russian air display this summer was extended to senior R.A.F. officers. Marshal Bulganin and Mr. Kruschev were shown one of the married quarters on the station before returning to London Airport in the Viscount.

Earlier that day, in an after-luncheon speech at the British Industries Fair, Birmingham, Mr. Kruschev had claimed that the Russians would have a guided missile that could deliver a hydrogen-bomb warhead anywhere in the world; and that Tupolev was building an airliner [a turboprop, according to one report of the speech] to carry 170 passengers, and another, a "two-engined jet airliner", to carry 47 at 850 km/hr (over 500 m.p.h.).

Before leaving London Airport for Birmingham the visitors inspected a B.O.A.C. Britannia under the guidance of Sir Miles Thomas, who told them that next November the aircraft was likely to visit Moscow with the Sadler's Wells Ballet company on board.

HIS MAJESTY'S PLEASURE: King Gustav of Sweden inspects the cockpit of a Hawker Hunter F.4 (known in Sweden as the J34) under the guidance of Major Dick Stenberg, who delivered the first Swedish Hunter from Dunsfold last year. Note the ejector-seat warning.

M.o.S. Appointments

IT was announced from Downing Street last week that with the Prime Minister's approval the Ministry of Supply has appointed Sir Cyril Musgrave to be Permanent Secretary of the Ministry. He succeeds Sir James Helmore, who is retiring from public service, and he will take up his duties on July 2nd.

Sir Cyril, who played an important part in the aircraft production organization during the war, is at present Second Permanent Secretary. This post is now to be converted into one of Deputy Secretary and will be filled by Mr. Peter Humphreys-Davies, who, on loan from the Treasury, is at present on the directing staff of the Imperial Defence College. Mr. Humphreys-Davies is to take over, from Mr. L. J. Dunnett, the administrative divisions concerned with aircraft, electronics and guided weapons matters.

Mr. Dunnett will in turn assume certain of the responsibilities hitherto undertaken by the Second Permanent Secretary and, in addition, will be responsible for general administrative and financial co-ordination of the Ministry's research and development programme.

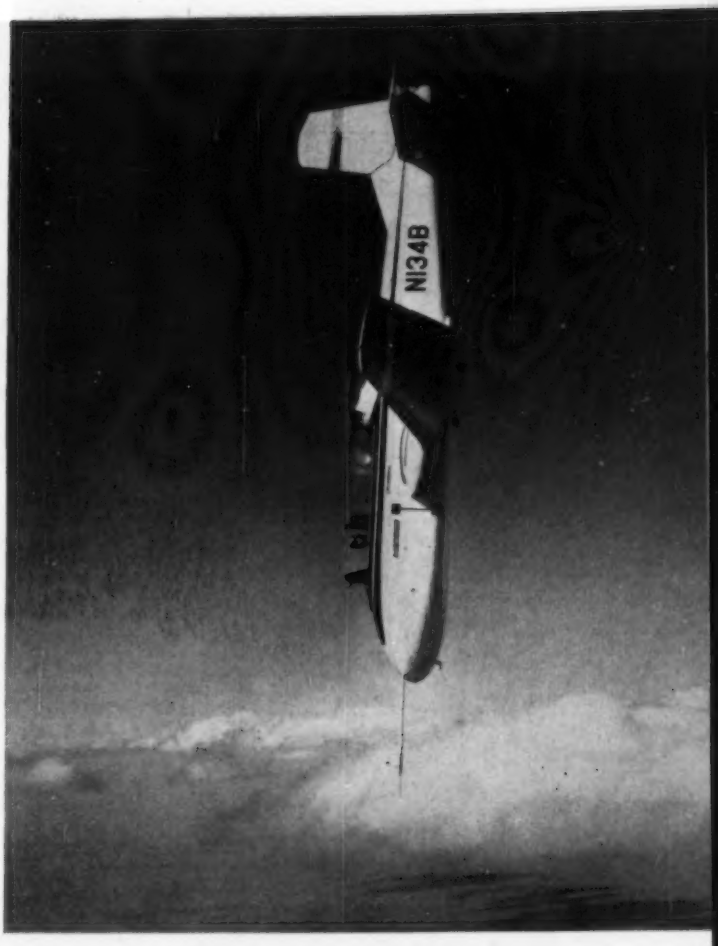
Hushing-up Canberras and P.1s

LOCAL authorities of the areas surrounding the Samlesbury and Warton airfields of the English Electric Company were last Friday invited to a meeting to hear details of the steps which the company proposes to take to alleviate the noise nuisance. They were given a general explanation of the problems from the aircraft manufacturer's point of view and were shown models (photographs, col. 1) of some of the silencing equipment which is to be installed at the two airfields and which should be in operation early next year. Warton and Samlesbury will have a muffler each, and the one at the latter airfield will be fitted with a "Y" adaptor to permit its use by Canberras as well as by P.1s. It was explained that as P.1s begin to appear in larger numbers at Samlesbury, the noise level will tend to increase, even with the muffler—though it would probably not amount to as much noise as is made by an unsilenced Canberra.

The company intended to do all installation tuning (two or three hours on each engine) with aircraft against the muffler, but this would not be practicable for the 10-15 minutes' running of pre-take-off checks.

The visitors were also told about supersonic bangs, it being explained that it was the company's general practice to carry out

ANCIENT ARTILLERY is suggested by the nose-ducts to be wheeled up to a "muffled" Canberra, which would otherwise have to be turned directly into the wind before the engines were opened up. The second view of the English Electric model (see news item, right) shows a Canberra with its tail-pipes connected to the "Y"-shaped muffler intake. A Detuner silencer is incorporated.



***JET MENTOR:** An exhilarating study in light and shade is this new picture of the Beech Model 73 Jet Mentor, the relationship of which to the piston-engined T-34 Mentor is instantly apparent. Flight trials are being conducted with a Continental J69-T-9, a developed version of the Turboméca Marboré 2 of 920 lb thrust.*

as much test flying as possible, particularly with the P.1, over the Irish Sea.

The company had been trying to eliminate all flying and ground running tests on Sundays. There had been none for the past two years at Samlesbury, and from now onwards there would be none at Warton, except under very exceptional conditions. Instead, they were arranging to fly later every evening and all day on Saturday.

Folland Prospects

IT is reported that the first of six Folland Gnats of a development batch ordered by the Ministry of Supply last year is likely to be handed over within the next few weeks, only nine months after the contract was placed. Though official support for this private enterprise aircraft does not go further than this order, Folland Aircraft, Ltd., are busy setting up a production line. Jigs are being erected as fast as floor space can be found, and the company believes that between 20 and 30 Gnats a month could be built without any increase in their present plant resources.

Countries that have so far shown more than a passing interest in Folland's light fighter include India, Finland, Holland, Belgium, New Zealand, Germany, Yugoslavia, Switzerland and Israel; and both the Royal Canadian and United States Navies have expressed interest in a carrier-borne version, to be known as the Sea Gnat.

Cranfield S.C.R. Dinner

A FORTHRIGHT warning of the dangers of over-specialization, and blunt incidental criticism of recent B.O.A.C. appointments, were features of a powerful speech by Lord Reith at the eighth annual dinner of the Senior Common Room Society of the College of Aeronautics at Cranfield on Friday last, April 20th. If the academic staff of the College could give students an idea of the wider problems to be faced in life, and could warn them of the dangers to this country and how to meet them, he said, they would be doing a great service to the nation.

Proposing the health of the Society, Lord Reith emphasized the need for men to take a broader view than that of narrow specialization. A vast materialism was pressing in on this country from both East and West, he said, in each case accompanied by an unquestionable reliance on the technical specialist. In an incidental reference to the recent B.O.A.C. top-management appointments, which Lord Reith described as "shocking," he questioned the Government's realization of the difference in function between the Corporation's Board and its executive. Why bring a civil servant in, he asked, and why appoint him deputy chairman? If a system was wrong in principle, he concluded, it would be unsound in policy and pernicious in execution.

Earlier speeches at the dinner had been made by Dr. S. J. Davies, Dean of the Royal Military College of Science, Shrivenham, who proposed the health of the College; and Prof. A. J. Murphy, Principal of the College and president of the Society, who replied. Professor Murphy expressed his opinion that the College had progressed faithfully along the course set for it in the Fedden Report of 1944; the increased annual intake of students which was hoped for, he went on, would not be obtained by a reduction in academic standards.

Replying to Lord Reith's toast to the Society, Mr. T. L. Palmer, Warden of the College and chairman of the Society, expressed the pleasure of the Society at the efforts of one of its previous members—Mr. (formerly Professor) R. L. Lickley, who had been responsible in large measure for the recent regaining of the world speed record by this country. After referring to the progress of students who had passed through Cranfield during the last ten years, the speaker emphasized that students' grants needed urgently to be increased.

Concluding speakers were Rear Admiral Sir Matthew Slattery, who proposed the health of the guests, and Mr. G. W. H. Gardner, who replied. Some 175 members and guests—the largest attendance at any of the Society's dinners—were present.

The Last Firefly

THE Fairey Aviation Company has delivered its very last Firefly. At Ringway Airport, Manchester, last Friday the aircraft was handed over by Mr. Richard Fairey, general manager, and accepted by Mr. H. M. Kemp, of the Aeronautical Inspection Directorate, on behalf of the Ministry of Supply.

A target drone, described as a U(unmanned).Mk 8, this last aircraft, WP354, will remain in store at Ringway until it is needed for guided weapons training. Other Fireflies will also be employed on these duties, but they will be conversions of aircraft released from the Fleet Air Arm.

Altogether, 1,702 Fireflies have been built. A versatile aircraft which was ultimately to amass an excellent war record in a variety of rôles and operational theatres, the Firefly was born in early 1940 as a result of two specifications issued in 1939. An order for 200 "off the drawing board" was placed in June 1940 and the prototype first flew in December 1941; within 12 months deliveries had begun. The order for 200 was increased in 1943 to 800 and later to the final total of 1,702. Of these, 740 Mk 1s, 160 Mk 4s, 352 Mk 5s, 133 Mk 6s and 110 Mk 7s were built by Fairey at Hayes; 41 Mk 7s and 34 Mk 8s at Stockport and Ringway; and 132 Mk 1s by General Aircraft, Ltd.

***LAST OF THE LINE:** WP354 photographed before the handing-over ceremony at Ringway (see "The Last Firefly," above).*

HOLLYWOOD PREMIÈRE

HOLLYWOOD ballyhoo is frequently employed to give an artificial build-up to something which does not usually merit the "stupendous-colossal-spectacular" adjectives applied to it; yet this was certainly not the case on April 17th, when the U.S.A.F., Lockheed and General Electric shared in the unveiling of the world's fastest combat aircraft, the Lockheed F-104A Starfighter. As we described in some detail last week, this remarkable aircraft is designed for speeds approximately twice that of sound, and, with some compromise in performance, can be adapted for a multitude of military tasks. These photographs, specially taken for us at the unveiling by Harold G. Martin, are certain to evoke wide interest.

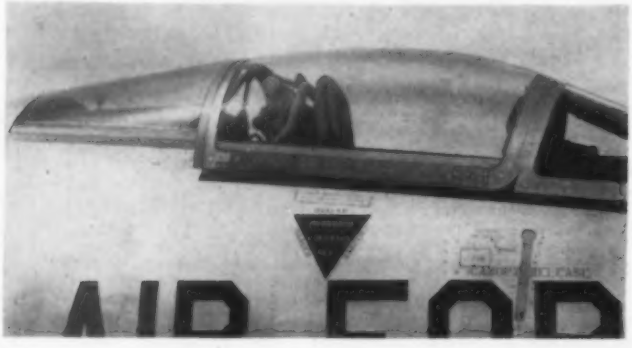
(Left). Believe it or not, the unveiling of the Starfighter actually took place not in a public theatre but at the south-west end of Lockheed's production flight building at U.S.A.F. Plant 42, Palmdale. Observe the notice.

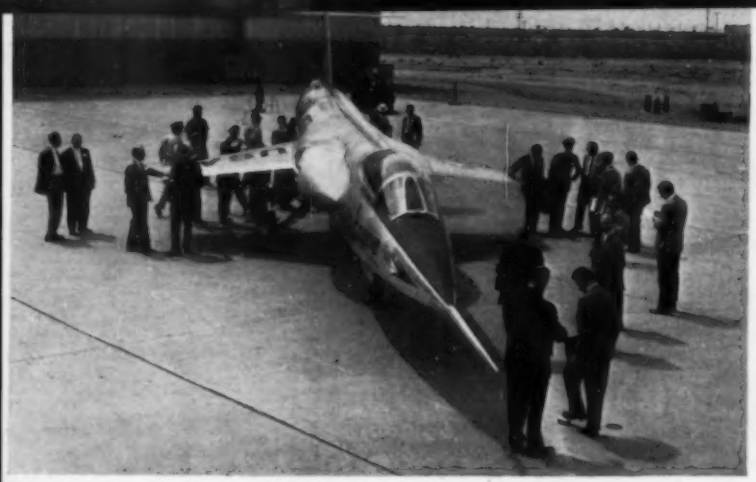
(Right). The button was pressed by Gen. Otto P. Weyland, Commanding General of the U.S.A.F. Tactical Air Command and thus the first customer of the Starfighter. With him is Mr. Robert E. Gross, Lockheed president and board chairman.

(Left). Although the jettison seat ejects downwards the pilot climbs aboard conventionally by opening the finely profiled canopy.

(Left, below). Here, we tried to record the profile of the 3.4 per cent wing, the characteristics of which were described in some detail last week. Incidentally, the aileron booster jacks are not in the fuselage.

(Below). The U.S.A.F. pushed a blanking cap over the Starfighter's rear end to prevent people from measuring the propelling nozzle. We hear that they were inspired to do so after reading "Flight's" assessment of the Tu-104. In spite of this, the thrust of the J79 is accurately known.





After the unveiling, the F-104A —with its intakes blanked off, as we lamented last week—was rolled outside on to the apron. There our photographer found the test pilots "Fish" Salmon (left) and Joe Ozier, who shared the flying on April 17th.

Undercarriage geometry was described in some detail last week. All F-104s have four wheel doors, the rear pair being linked to the unusual main legs. The nose undercarriage unit (far left) is steerable.

At take-off the YF-104 presents a fearsome aspect, the incongruity of which is in no way lessened by the grotesque retraction sequence of the landing gear. The photograph was taken 5,000ft from the end of the Palmdale runway; speed was approximately 240 knots. (This aircraft is a J65-powered prototype. No production F-104A was allowed to fly close to the ground, owing to the secrecy surrounding its intakes, which have shock-forming wedges extending well forward to give multi-shock diffusion.)

Landing, the same aircraft—one of the J65 Sapphire-powered prototypes—streams its braking parachute to ease the wear and tear on the Bendix multi-disc brakes.

HERE AND THERE

NATO Post

THE newly-created post of Air Defence Co-ordinator, Europe, has been given to Lt-Gen. Guillaume Chaffin of the French Air Force. The appointment is announced by H.Q., Allied Air Forces Central Europe.

Douglas C-133A Flies

THE massive C-133A turboprop transport, a detailed description of which appears in this issue, made its first flight from Long Beach, California, on April 24th. Powered with Pratt and Whitney T34s, it has a span of 179ft 8in.

Gift to India

M. HENRI LAFORZST, French Secretary of State for Air, speaking in Calcutta last week, revealed that France is presenting two transport aircraft, one light aircraft and a helicopter (types not specified) to the Indian Government as a token of friendship.

Rotor Ambulance

A WHIRLWIND helicopter from R.N. Air Station Lee-on-Solent went out to a Norwegian whale-oil ship off the Isle of Wight last Sunday to pick up an engineer who had been taken ill. He was landed on a cricket ground 200 yards from the doors of a hospital at Chichester.

More Japanese Production

TOKYO RADIO reported last week that under an agreement signed on April 17th the production in Japan of jet trainers and intercepters for the Air Defense Force will be increased to a total of 360 aircraft. This follows a similar agreement signed last June. The order is to be completed by the end of June 1958.

Guild's New Clerk

IT is announced that Major J. L. B. H. Cordes, F.R.S.A., A.F.R.Ae.S., has been appointed clerk to the Guild of Air Pilots and Air Navigators in succession to Mr. L. A. Wingfield, M.C., D.F.C., who retired on December 31st. Maj. Cordes has had a long and distinguished flying career and saw service with the R.F.C. in the First World War, and later as a flying instructor in the R.A.F. After leaving the Service he became well known in the industry as a research and experimental pilot. He is a founder member of the Guild and was elected a member of the first Court, later becoming a warden. Since 1950 he has served the Guild as secretary. It is also announced that Miss G. Mackay has been appointed secretary to the Guild and will take up her duties early in May.

Home on the Range

IN reply to a Parliamentary question last week the Air Minister said that the total strength of personnel at the Hebrides Guided Weapons Establishment, on the island of Benbecula, would probably be over 2,000. This would include aircrews and ground crews at the airfield and men under training at the South Uist rangehead; the permanent staff of the establishment would be about 600.

Canadian Test-pilot Group

FOLLOWING an initial meeting in Ottawa, pilot representatives of the Canadian Services and Industry met in Toronto on April 14th to discuss the organization of a proposed Association of Test Pilots. The new group would aim at broadening professional relationships among members, providing a medium for discussion of new phenomena and flight safety, exchanging information for the development of test techniques, and providing opportunities for technical advancement.

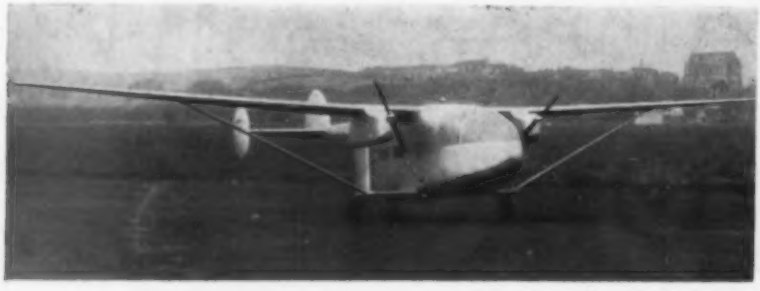
THE WORLD'S ENGINES

ON May 11th—a fortnight hence—the special "Aero Engines of the World" number of *Flight* will appear. Contents will include an appraisal of design-trends in the supersonic turbojet, and a review of the notable power units of all engine-manufacturing countries.

Farnborough Tunnel Opened

OFFICIAL opening of the 8ft × 6ft transonic wind-tunnel at the Royal Aircraft Establishment, Farnborough, was performed by the Minister of Supply, Mr. Reginald Maudling, on April 17th. As described in *Flight* of February 25th, 1955, the installation is a modified and improved version of the well-known 10ft × 7ft high-speed tunnel which began operation during the last war. Closed-circuit television will be used to enable the working section to be viewed from the control room.

MILES MODEL at Shoreham is that of the HDM.105—a Miles Aerovan fitted with a Hurel Dubois high aspect-ratio wing. The aircraft itself, the company states, should make its first flight within the next few months, and will be used for a comparative performance evaluation with the original Aerovan. A 15-seater all-metal development of the HDM.105, powered by Gipsy Queen 30 or Continental O-470B engines, is the subject of a Miles design study.



POTTING FROM A PO-2: Inscribed on this photograph was: "Tatar Autonomous Republic, U.S.S.R.: Famous Russian Hunter, Sergei Gorbunov, stands with his rifle, surveying the corpses of his latest wolf-hunt. Hunting wolves from the air has been organized in some areas of the Russian Federation in an attempt to reduce the number of the beasts, which ravage other animals of the outlying farms. Gorbunov has killed over 1,000 wolves from the air in the past few years. . . ." In the background is the PO-2 he uses with pilot I. Rakhimov (on wing).

Haste from the Wedding

CINE films of the Rainier-Kelly wedding were flown from Monaco to Nice by helicopter and thence in a Mistral fighter to Paris, where they were processed and put aboard a T.W.A. airliner for New York.

Test Pilot Saga

IN its Light Programme on May 1st, the B.B.C. is to broadcast a feature entitled *The Peter Twiss Story*. The Fairey test pilot will take part in the programme, which tells of his flying career, culminating in the capture of the world speed record with the F.D.2.

Out and Away

TODAY'S (April 27th) issue of *The Autocar* is a special Spring and Touring number. The increased contents include information and advice on touring in the British Isles and abroad; a feature for caravanners; and a review of special touring equipment. Also in this number is the first report of the Turin Show.

Woomera Accident

A REGRETTABLE accident occurred at the Woomera range on April 19th, as a result of which Mr. T. E. Lister, an employee of de Havilland Propellers, Ltd., lost his life and five other technicians engaged on guided-missile work were injured. It appears that the propellant was accidentally ignited while a missile was being prepared in a hangar for firing.

For Speeding-up Industry

THE fifth Mechanical Handling Exhibition and Convention opens at Earls Court, London, on May 9th, and continues until the 19th. Published just before the opening, a special preview number of the monthly journal *Mechanical Handling* will include a full list of exhibitors, a plan of the exhibition, and the programme for the convention. The exhibits will be described in detail in the subsequent Exhibition Report Number early in June.

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The Goodyear GA-400R (left) and the Gyrodyne XRON-1 ultra-light single-seater helicopters both have a loaded weight under 500 lb.

LIGHTWEIGHT QUARTET

THREE American and one Dutch helicopter, lightweights all, are featured in the comparative views on this page. They are the Goodyear GA-400R, the Gyrodyne XRON-1, the Hiller HOE-1 Naval version of the HJ-1 Hornet, and the prototype Sobeh H-2 experimental machine which has now been named the Kolibrie. Brief progress notes on these four types follow.

The Goodyear GA-400R one-man ultra-light helicopter is powered by an Outboard Marine and Manufacturing "Big Twin" water-cooled, two-stroke engine of 31 h.p., and has a gross weight of 435 lb. Designed for courier-liaison, rescue, and tactical use, the machine has now completed its period of initial flight testing.

The airframe, of welded aluminium tubing, is supported by steel outrigger tubes on the alighting gear of parallel aluminium skids. The main rotor is driven at a 10 : 1 reduction from the engine through a toothed-pulley/timing-belt arrangement, the tail-rotor drive consisting of a 2 : 1 reduction through vee-belts.

Normal cruising speed is 40 kt, with a cruise endurance of 45 min. Main-rotor diameter is 18ft, empty weight 235 lb, and fuel capacity 3.2 U.S. gallons.

The Gyrodyne XRON-1 "rotor-cycle," powered by a 40 h.p. Nelson H-52 flat four air-cooled two-stroke engine, has co-axial contra-rotating two-blade rotors. It is a one-man portable machine under development for the U.S. Navy for use by the Marine Corps, and has been designed with the two main objectives of extreme simplicity and economy of large-scale production. The prototype, at a weight less than 500 lb fully loaded, has recently undergone evaluation tests.

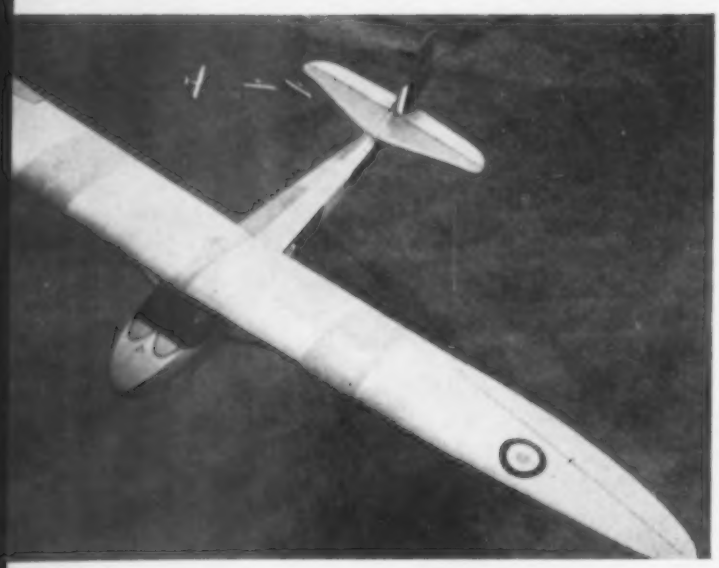
The Hiller HJ-1 Hornet is designated the YH-32 by the U.S. Army and the HOE-1 by the U.S. Navy, the latter production version being illustrated below. Two Hiller 8RJ2B ramjet units are fitted, one at the tip of each rotor-blade, fuel being pressure fed by separate pipes from a tank mounted in the fuselage. The machine is a two-seater having a loaded weight of 1,080 lb.

Each ramjet unit develops the equivalent of 45 h.p. and weighs only 12.7 lb. Fuel capacity is 52 U.S. gallons, and top speed of the machine is 80 m.p.h.

At Rotterdam, the second prototype of the Sobeh H-2 Kolibrie is nearing completion and should make its first flight next month. As shown below, the first prototype is now fitted with a full-depth windscreen. Tip-mounted ramjets together producing the equivalent of 100 h.p. are incorporated, and production units are to be built by the Kromhout engine company.

Other sections of production machines are to be manufactured by Fokker (rotor-blades) and Aviolande (fuselage and other components). A notable feature of the flight tests carried out on the prototype recently has been the hands-off stability of the machine.

Tip-mounted ramjets provide a common feature between the Hiller HOE-1 Naval two-seater (left) and the Sobeh H-2 Kolibrie.



Hawkinge impressions (reading anticlockwise from top right): a Primary is given the rare chance of a winch launch and some real flying—for demonstration purposes only; a Sedbergh on final approach; a T.31 being launched; a close-up of a Sedbergh over the airfield; and T.31 ground-handling after a first solo by Cadet Michael Walker. "Flight" photographs

Gliding at Hawkinge

The Home Command Gliding Centre

THE attractive recruiting bait that is A.T.C. gliding, which accounted for almost 100,000 launches during 1955, has since September last been offered in the form of continuous courses, as well as normal weekend training. These one-week courses are provided for A.T.C. and C.C.F. cadets, in addition to other gliding training, at the Home Command Gliding Centre, a lodger unit at the R.A.F. Station, Hawkinge, Kent.

Until September 1955 gliding instruction for cadets was provided at 43 weekend gliding schools throughout the country. For reasons of economy, it was then decided to reduce the number to 20, the aim being to maintain the annual number of cadets trained at the existing level. This was accomplished by the setting-up of the Home Command centre at Hawkinge, which also took over the functions of the previous Instructors' School at Detling, and the start of one-week courses for cadets not having access to local gliding schools. Some 400 cadets are expected to be trained annually at the centre.

Cadets begin their course at Hawkinge with basic training on Slingsby T.21B Sedberghs, and this is followed by dual circuit practice on T.31 Tandem Tutors (known in the Service as Cadet Mk. 3s). After a total of some 30 launches, first solos are made from the front seat of the T.31, and most cadets achieve proficiency certificates equivalent to F.A.I. "A" and "B" certificates, having logged 35-40 launches during the week. Selected cadets may receive further training and may obtain advanced certificates of F.A.I. "C" standard. All launches are by winch.

The total number of A.T.C. launches achieved last year was 99,449, the number of proficiency and advanced certificates awarded being 1,585 and 86 respectively. While the Command Gliding Centre at Hawkinge is staffed by regular R.A.F. personnel, plus J-class officers and civilian instructors, each of the 20 weekend schools has four R.A.F.V.R.(T) officers and about nine civilian instructors. Commanding Officer of the Hawkinge centre is F/L. R. C. Jones.

The training and checking of gliding instructors is another responsibility of the Hawkinge unit, two months of each year being set aside for categorizing and re-categorizing. Between 35 and 40 continuous courses for cadets are organized annually and, in school vacation periods, the schoolmaster instructors who give "football pitch" training hops in primary gliders to school cadets are themselves trained in the techniques of such instruction.

[*Gliding Instruction for Naval Cadets: page* 494]

COMMUNICATIONS FLIGHT, KADUNA

Pioneering Work in Northern Nigeria: An Apache Delivery Flight

WITH the recent delivery of the first Piper Apache to be operated by the Northern Regional Government of Nigeria, the work of that region's official Communications Flight has entered a new and important phase. Formed just over a year ago, in March 1955, the unit has since been engaged on a preliminary programme in which airstrips were laid down, proving flying performed with Auster Autocars, and the general foundations laid for a regular and comprehensive network of routes. With the first Apache delivered, and a second on order, the benefits of the initial groundwork have begun to appear. During the recent Royal visit the Apache was used by the Governor of Northern Nigeria as his personal transport on this State occasion, and as a general utility machine carrying members of the Household, mails and Press material for the Royal visitors.

The centre of operations of the Communications Flight is the Governor's headquarters at Kaduna and, indeed, it was largely due to the enthusiasm of the Governor, Sir Brian Sharwood Smith, that the scheme to open up the northern area by air was begun. Overland communications between the various divisional headquarters was previously an extremely slow process, because of the difficult nature of the forest, bush and swamp areas and the long distances involved.

The first task was the clearing of simple airstrips, usually by means of bulldozers and native labour. The natives employed on these projects were often unaware of the purpose of their work until they saw the first aircraft land on the strip; in many cases the curiosity of tribal chiefs was satisfied by their flying on demonstration trips over their own localities. Typical size of the strips is 1,800ft × 200ft, and each is normally associated with one of the divisional headquarters.

The work of the Communications Flight is concerned mainly with the administration of the Northern Region, enabling ministers more easily to travel among their constituents; government officials to visit the various provinces and divisions; and the Governor himself to attend in person many official functions. In addition, the aircraft of the Communications Flight are available for emergency duties such as ambulance work.

Operations were begun in April of last year with two Auster Autocars which, after being shipped out to Lagos and there assembled, were flown to Kaduna and immediately put to work. The fleet is now being built up, as mentioned, by the addition of two Piper Apaches, this type having been chosen for its good hot-weather performance, all-metal construction and ease of entry and exit for passengers.

The operations of the Flight have made possible one-day round trips in place of overland journeys which previously occupied a full week. The journey from Kaduna to Jos, previously taking 5 hr and 150 miles by road, now requires only one hour by air for the direct (100-mile) trip. During much of the rainy season, also, journeys by road were impossible, whereas flying can and does continue. Heavy showers and occasional line squalls are experienced during this season, however, which lasts from June to October. Another important weather factor is the Harmattan, a dry heavy dust storm which blows down from the desert during the period from November to January. In spite of these weather hazards, flying conditions in general are good, the chief pilot told *Flight* in a recent interview, there being 100-mile visibility for some ten months of the year.

At the opening of Jalingo airstrip, natives who had worked to clear the strip had their first view of any aircraft—one of the flight's Austers, from which this picture was taken.

The aircraft maintain H.F./R.T. communication with the ground stations at Kano and Lagos, and use also the nine non-directional beacons in the northern area. Because of its location the unit carries a full range of aircraft and equipment spares, and is self-contained except for major engine overhauls.

It is probable that the regional governments of Eastern and Western Nigeria may also set up flying units similar to that of the North. The conditions are not as favourable, nor the need as great, however: whereas the northern population is scattered, the towns few and widely spread, the cost of roads prohibitive, and the clearing of strips relatively simple (average height of trees being about 12ft); the eastern and western regions possess many villages, closer together and joined by better roads, while 300ft-tall trees make the prospect of clearing strips formidable and expensive. The respective climates, also, are different; the eastern and western regions being tropical and the north sub-tropical and drier. Kaduna, elevation 2,116ft a.s.l., is indeed claimed to have almost a temperate climate.

The minimum stage-length flown by the Northern Region's Communications Flight is about 125 miles, mostly over scrub and bush terrain. As indicated, the scope for aircraft in opening up a system of fast communications in Northern Nigeria is great. With commendable speed the initial groundwork has been accomplished, and this small yet active unit has now many years of intensive development and useful flying ahead.

The first Apache was flown out to Kaduna early this year by Capt. E. Minshaw, chief pilot and officer-in-charge of the Communications Flight, who was previously a flying instructor with the Liverpool Flying Club. His description of this flight follows.

Leaving Gatwick [Capt. Minshaw writes] we flew to Paris, where we waited while the aircraft was given a U.S. Certificate of Export so that it could eventually have a Nigerian C. of A. As the main agent for Piper Aircraft in Europe is based in Paris, we took the opportunity of having the remaining radio installed and of discussing spares. No sooner was all the radio work and the paper work tied up than the weather set in with fog.

An unforeseen break appeared on January 20th, and I took this opportunity of getting away. As take-off was in the afternoon I only managed to reach Bordeaux, where I stayed the night. On arriving at the airport next day I found a very dull picture presented on the weather chart: the whole of Spain was covered with a front and most of Southern France was covered with fog. The only course open was across to Perpignan and then down the Spanish coast to Valencia. The Pyrenees, capped in snow, were standing out from the mist and gave a good indication of position for the course. Perpignan was reporting good weather, and so a landing was made there for more fuel and further met. reports. The front was moving down south and, by leaving

First of two Piper Apaches for the government flight, VR-NBF was flown out to Kaduna by Capt. E. Minshaw, officer in charge of the unit.

COMMUNICATIONS FLIGHT, KADUNA . . .

Perpignan by 1400 hr, I made Valencia in the wake of the bad weather.

Next morning broke clear, with a few scattered clouds. Cutting across the south-eastern tip of Spain, I saw the Mediterranean sea was its usual deep blue and, in spite of a few wisps of cloud covering the tops of the mountains, it was certainly one of those days when one feels glad to be flying an aeroplane. Even when the undercarriage kept falling down, indicating a hydraulic leak, the beauty of the mountains and valleys was such that it took one's mind off the possible consequences. I reduced my speed and locked the undercarriage down—now it would at least be safe to land on. Reaching Gibraltar, I thought that this base would be the best bet for repairs, for at any rate the occupants spoke English. Although it was Saturday, the R.A.F. turned out and put the aircraft in flying order, and I continued to Tangiers.

On landing there I checked in about the same time as a Hunting Clan service and, because of the disturbances which were prevalent in North Africa, was very glad to have their company. The night passed peacefully, however, and next morning found me on my way to Casablanca.

Even after all my preliminary study of the route, one thing I had not bargained for was the methodical detail with which the French examined the equipment and aeroplane at Casablanca. The necessary purchase of extra water-tanks there delayed me another day. Still, having adopted the French belief that one lives for the purpose of eating, my stay in Casablanca was quite pleasant. After take-off the next day the Apache was floating nicely on a southerly course, with the warm sun pouring in through the canopy and a beautiful view of the snow-capped Atlas Mountains to the east, when the whole serenity of the trip was shattered by two exuberant U.S.A.F. Sabre pilots, who, recognizing the American markings of my machine, proceeded to perform every aerobatic evolution possible—and a few more. After a final attempt to fly alongside, they waved and departed.

Leaving the green vegetation of the north for what was becoming the scrub and sand of the desert, we were now entering the desert control zone and at midday had reached a place called Sidi Ifni, another Spanish outpost. By the time I had made myself understood, aroused the various officials from their siesta and filled up with petrol, I had only sufficient time to make Cap Juby before sunset.

Cap Juby is another Spanish outpost in the desert and the only means of communication with the outside world is by an old Junkers Ju52 and by radio; consequently any strange face is very welcome. Even the language was no bar and, as they could speak a little French and so could I, we had a very enjoyable time.

Take-off was a little delayed next morning until a mild hangover had cleared; but, even so, we made Port Etienne by early afternoon. Towards the evening the desert was fading into a greenish haze again and the lights of Dakar were just beginning to show as I touched down there. The airport is quite a way from the town and so I stayed at an excellent nearby hotel overlooking the Atlantic. Tired as I was, the sound of the surf kept me awake for a long time.

The Apache parked next to the Queen's Flight Viking in which the Queen flew from Lagos to Kaduna during her recent visit to Nigeria.

By now the weather was becoming warm and humid and it was a very pleasant idea to crawl into the air again. After the usual language and Customs palaver, I took off for Freetown. The ground was really green now, with almost a jungle growth around the river, and then the usual West African haze, the desert dust blowing down to the south reducing visibility to less than a mile. It was nice to find Freetown and have lunch with people who spoke English. Becoming airborne was delightful, for it was past midday and the sun was pouring out its full heat. By the time a height of over 10,000ft had been reached conditions were reasonably normal and course was set for Robertsville. This is quite an outpost of the U.S.A. as the whole station is taken over for the purpose of running the services of Pan American Airways. The base is certainly an efficient one and the fact that everybody speaks English is an added advantage. I finished flying for the day there to have a rest on the beach.

Next day the mist was down and take-off was delayed until 1000 hr, after which the route was bordered by line squalls and thunderstorms, truly indigenous to the west coast. Beyond the haze and the storm, the run into Abijan was uneventful; and, as this was the last stop before Lagos and in French territory, I made the most of the French cooking there. After eating for almost an hour and a half, it was very difficult to make the effort to get into the air again . . .

The run into Lagos was uneventful. I arrived there amid Canberras, Hastings, Dakotas and every conceivable type of aircraft converging on the airport for the visit of the Queen. But it was nice to be back in home territory again. I stayed the night in Lagos and slept well into the next day, eventually setting course for Kaduna, where I landed in time for lunch, just two days before the Queen arrived in Nigeria.

GLIDING INSTRUCTION FOR NAVAL CADETS

THE training syllabus for all cadets at the Britannia Royal Naval College, Dartmouth, includes a short course at a Naval air station. But the keen youngster who cares to sacrifice part of his summer vacation can at no financial cost to himself gain a valuable introduction to flying by volunteering for one of the annual gliding courses held at Royal Naval Air Station Bramcote, in Warwickshire.

Glider flying for Dartmouth cadets, during which they can qualify for the Royal Aero Club "A" and "B" gliding certificates —and, if time allows, the "C" soaring certificate—was first instituted in 1948, a year after the formation of the R.N. Gliding Association. The courses were started by Lt-Cdr. J. Sproule, who has himself represented the Navy in team gliding contests.

Three courses, of ten days each for twelve cadets at a time, are held at Bramcote during the Dartmouth summer vacation. The present chief instructor is an officer belonging to the College training staff who is a glider expert, and three or four assistant instructors from branch clubs of the R.N. Gliding Association are appointed to Bramcote for the duration of the courses.

The gliders used are the Slingsby T.31 Tandem Tutor, the single-seat Kirby Cadet, and a number of SG.38 primaries. A Tiger Moth is available for aero-towing.

The cadets join Bramcote on the day before the commencement of each course, so that they have time to get settled in. Next morning they are given a brief insight into life on a Naval air station, and then turned over to the gliding instructors. Tuition starts with a lecture on the elementary principles of flight, a met. briefing, and inspection and handling of the gliders on the ground.

The cadets are then split up into smaller groups with two instructors to each and the chief instructor in overall charge. Each pupil is taken up for an initial flight in the T.31 on tow, with the instructor in the rear seat, to show him the airfield layout and demonstrate the controls. Then follows a certain amount of dual instruction, after which the pupils start doing ground slides in an SG.38 primary towed behind a jeep.

Flying goes on from 9 a.m. to 7 p.m., with short breaks for meals, the Tiger Moth pilots logging something like five hours' towing time daily. While some of the pupils are on primaries others are receiving dual tuition.

After three days, during which each cadet gets in about a dozen flights, the instructors are able to assess individual aptitude. Those sufficiently advanced move on to the Kirby Cadet to fly solo for their "A" certificate. Qualification for this is a flight of some 30 to 40 seconds at about 300 feet followed by a normal landing.

When the "A" certificate has been attained the pupils spend the rest of the time on the T.31. The course passing-out requirement, which includes the official requirement for the "B" certificate, is two solo circuits at a height of 700-1,000 feet from a winch launch, with right- and left-hand turns and normal landings.

More than half the cadets succeed in gaining their "B" certificate during the Bramcote course. If time permits they may try for the "C" certificate, qualification for which is a solo flight during which height is gained or maintained for five minutes. All the cadets get in some sixteen three-minute dual instruction flights during the course, three or four solo circuits, and upwards of 30 flights in the various types of glider. A. C. H.

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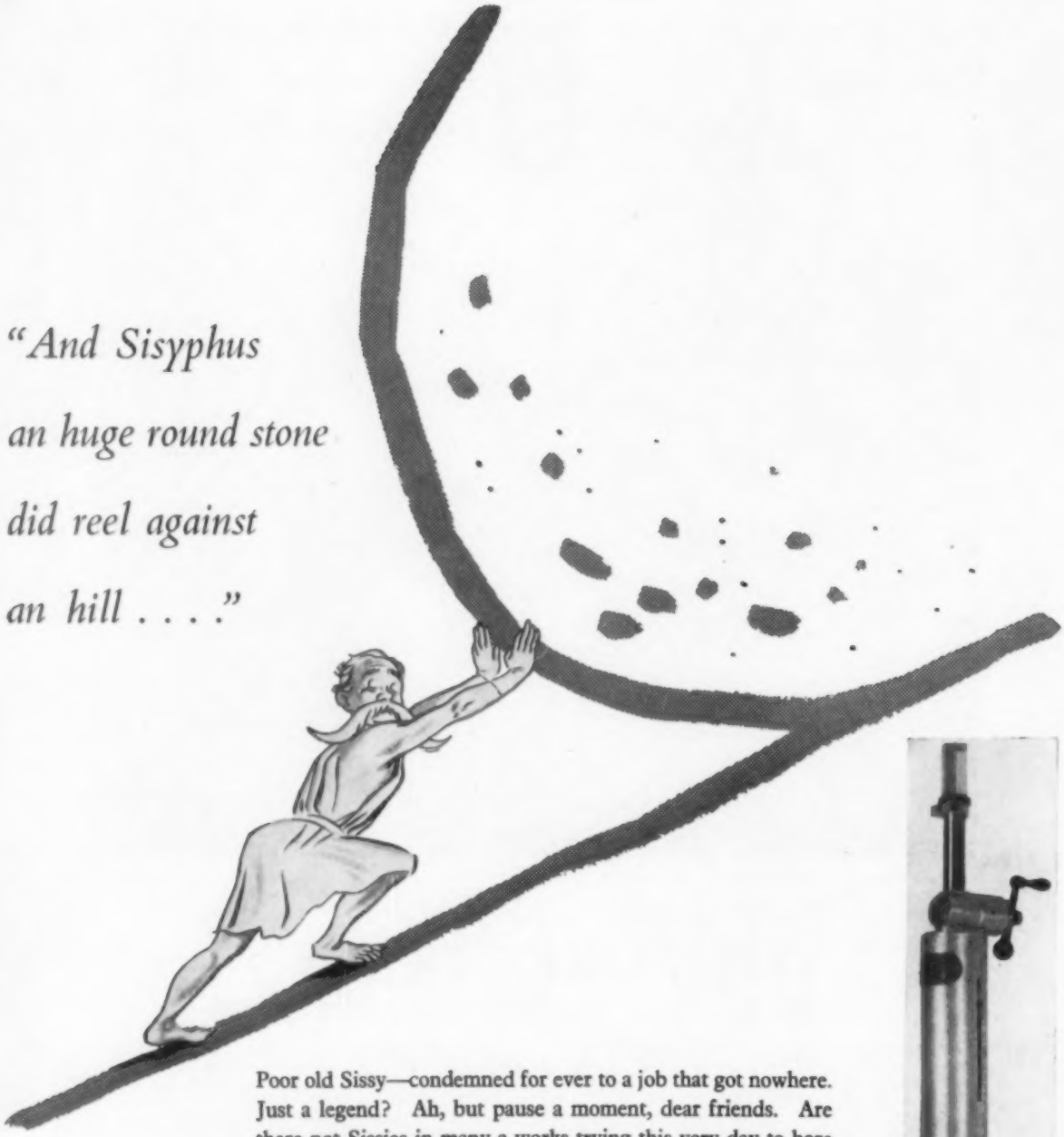
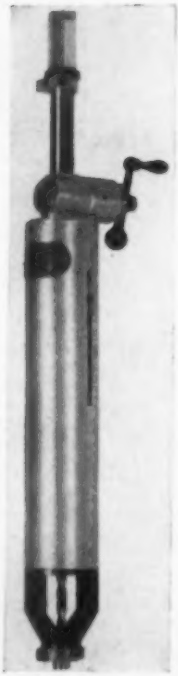
did reel against
an hill . . . ."





Poor old Sissy—condemned for ever to a job that got nowhere. Just a legend? Ah, but pause a moment, dear friends. Are there not Sissies in many a works trying this very day to bore half-inch holes through tough metal with the wrong tool?
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LONG-RANGE NAVAIDS

PART 1: The Background

By J. H. GROVER M.I.N.

DO present navigation aids really lag five years behind the development of aircraft? The author of this article discusses, in not-too-esoteric terms, the main British and American systems. In this first instalment he briefly reviews the history of established navaids and goes on to describe the operation of the two systems known as Consol and Loran. In Part 2 he will deal with two British systems, Dectra and Delrac, and with the U.S. Navarho and Navaglobe.

SINCE the earliest days of flying one of the main tasks facing the aviation industry has been the development of means to assist the pilot in as many aspects of flying as possible. Thus, following upon the basic panel instruments came gyro horizons, turn-and-bank indicators and the like, to assist the pilot in cloud or blind flying. Then, as the range of aircraft increased, further assistance was devised in the shape of the automatic pilot. In the same way, not only the actual flying of the aircraft was assisted but means were sought whereby its navigation could be aided. This resulted in the early direction-finding stations, airborne loop aerials, and, in the United States, the radio range. All of these systems were of great value, and development continued over the years.

Before World War 2 the primary system of navigational assistance used in the United Kingdom was medium-frequency D/F., and the civil network became tantamount to a standard. But aircraft range was already on the increase and, accordingly, means were sought to extend the range of this aid. As D/F. is essentially a directional receiver it is apparent that any significant increase in maximum performance must lie in the range of the transmitter. True, much can be done to increase receiver performance by increasing the efficiency of the aerial system, but in the end it becomes necessary to turn to the transmitter to obtain an increase in range.

Now, although increasing the power of the transmitter would, in the case of M.F. D/F., result in an appreciable increase in the range of the system this would result in an unacceptably large, heavy airborne transmitter, with a heavy current consumption. It is a fact that, up to certain limits, increasing the operating frequency of a radio transmitter will give a corresponding increase in range for a given power. However, once a certain frequency level has been reached other factors apply and the behaviour of the radio transmissions changes.

At the low and medium frequencies radio waves mainly follow the curvature of the earth, and their range depends on power. As the frequency is increased so the range is increased, but at the same time a proportion of the transmission is radiated upwards until it reaches an ionized layer in the atmosphere known as the Kennelly-Heaviside layer. This layer has variable properties, and although for a time high-frequency D/F. reigned supreme as the long-range navaid these variations—or "night effect" as it is usually called—made the aid obsolete fairly quickly, certainly as far as civil aviation was concerned.

As a result of further research very high frequency (V.H.F.) was developed, but here range was limited to line-of-sight conditions. At very high frequencies there is no ground wave, and no reflected wave; the entire transmission is radiated into the atmosphere and through the ionospheric layer. Solid obstacles in the path of these waves cause a "shadow" behind, and consequently it is theoretically necessary for the receiver to be able to "see" the transmitter. Power-increases, however great, have little or no effect on the increase in range above optical range.

It thus became necessary to develop all aids for long-range use to operate in the medium- or low-frequency bands, and for the receivers to be carried in the aircraft, with the high-powered transmitters on the ground. Two such aids were developed; still in use today, they are known as Loran and Consol.

Once the war ended the increase in air traffic became annually greater and, as everybody knows, an international body was constituted to deal with international aviation organization and development. Known as the International Civil Aviation Organization, this body maintains a number of technical panels devoted towards operational development. Two of them are most intimately concerned with the development of navaids; these are the Air Navigation Commission and the Communications Division.

A word here about current and projected short-range systems. At present the I.C.A.O. standard short-range and terminal aid is V.O.R./D.M.E. (V.H.F. omni-directional radio range with distance-measuring equipment). However, although this aid has been specified by I.C.A.O., the only country that can really claim to have implemented this decision is the United States. V.O.R. has, in itself, achieved fairly widespread installation, but a general dog-in-the-manger attitude has developed over D.M.E. I.C.A.O. has specified that D.M.E. should operate in the 1,000 Mc/s band, and this has been a bone of contention among countries outside the U.S. In the United Kingdom D.M.E. development has been directed towards the 200 Mc/s band, where the aid was first used as Rebecca/Eureka (and, for that matter, still is), although almost entirely for military purposes. True, Ferranti have produced an excellent 1,000 Mc/s system, but no installations have been made on an official basis.

The United Kingdom view is that Decca is the finest available short-range aid, and have placed it on record that it is the official intention to designate Decca as the aid on which U.K. Air-traffic Control procedures will be based. But, at the same time, although refusing to provide 1,000 Mc/s D.M.E., the authorities are to install a number of 200 Mc/s stations for B.O.A.C. use, retaining, at the same time, V.O.R. But V.O.R./D.M.E. is not sufficiently accurate in azimuth to permit lateral separation in air traffic, and neither is a comparable U.S. system known as T.A.C.A.N. This aid, which operates in the 1,000 Mc/s band, is a bearing-distance system, but according to official U.S. reports would appear to do very little more than V.O.R./D.M.E. can do. Decca, on the other hand, is entirely suitable for lateral separation procedures, while V.O.R. alone is a valuable secondary aid, especially as a single receiver may be used to receive both V.O.R. and I.L.S. with very little extra weight.

Now, although a considerable amount of post-war work had been done on the development of short-range aids for use in terminal or heavy traffic areas, very little comparable effort had been devoted to the provision of long-range assistance. In fact, the matter was not really spotlighted until 1954 when the Fifth Session of the I.C.A.O. Communications Division recommended States to develop a long-range navigational system. The Division specifically mentioned four projects as warranting further development; these were the Decca Navigator Company's Dectra and Delrac, and the U.S. Navarho and Navaglobe. The Division also mentioned Loran and Consol as good interim systems.

In September 1955 the Second Air Navigation Conference of I.C.A.O. really drew attention to the seriousness of the position when it disclosed the fact that the collision risk on the North Atlantic route in particular was becoming unacceptably high, and specified in very definite terms the requirement for an accurate navigational aid. The accuracy was to be such that throughout its coverage the maximum errors would not exceed 10 n.m. on at least 95 per cent of occasions. Range was to be 1,500 n.m. or over, except in cases where the length of the route makes this unnecessary. The presentation must be clear, self-evident and continuous, and must provide the pilot with an instantaneous reading of his position. Furthermore, sufficient information must be provided to enable accurate cruise control to be adopted, and lateral separation between aircraft to be achieved. Finally, the system must be capable of integration with a short-range aid.

Before discussing the position any further let us examine objectively the long-range aids in current use, and those projected.

Consol. During the last war, it will be recalled, the Germans launched an extremely efficient anti-shipping offensive, using submarines and long-range maritime reconnaissance aircraft. This combination resulted in serious Allied losses, and it became obvious that some special navigational assistance was available to both U-boats and aircraft. It did not take long for Allied technicians to discover the nature of this aid, and it is one of the more remarkable aspects of the radio side of the war that Sonne (as the Germans called the device), although easily jammed, was allowed to operate unmolested: the Allies put it to work in their own interests, mainly in the anti-U boat campaign.

When the war ended the Sonne installations fell into the hands of the Allies, and it became apparent that here was an aid that would have immense value in civil airline operations. Originally developed by the famous Lorenz concern, who had already provided pre-war civil aviation with the well-known beam approach system, Sonne was further developed by Marconi in the U.K. and renamed Consol. A British transmitter was installed for the Ministry of Civil Aviation at Bushmills, in Northern Ireland, and is still in full operation, just as an original German Station is operating at Stavanger, in Norway.

Operating in the medium-frequency band, on frequencies between 255 and 415 kc/s, Consol provides bearing information only at ranges up to 1,500 n.m. Accuracies are of the order of ½ to ¼ deg under daylight conditions, when ionospheric influences are not so pronounced; at night, the reflected sky wave from the Kennelly-Heaviside layer is comparable with the direct ground

LONG-RANGE NAVAIDS . . .

wave, and this may lead to errors of up to 2 deg in a zone over 350 and under 500 n.m. from the station.

The principle of Consol is a radiated pattern having many lobes, or sectors, rotated electronically. Each sector has either a dash or dot characteristic, such sectors being disposed alternately. The spacings between the dots and between the dashes are such that if the two characteristics are brought together a steady tone results, and this takes place on the boundary lines between the sectors.

The normal Consol transmission follows a complete cycle, which is repeated continuously; the cycle normally occupies 40 seconds. It consists of, firstly, the station identification signal followed by a two-second break. Then follows a succession of dots or dashes, a continuous tone, and then more dots or dashes. This cycle is caused by the rotation of the pattern, and the number of dots (or dashes) heard before the steady tone, or "equi-signal," determines the bearing of the receiver in relation to the transmitter. Thus, a navigator wishing to obtain a position line from the Consol transmitter merely has to tune into the station on the aircraft A.D.F. (or communications) receiver. He then counts the number of dots or dashes following the identification up to the receipt of the steady tone or equi-signal. This will indicate his position within the Consol sector, and by referring the received count to a chart overprinted with the Consol pattern a position line can be obtained.

It will be appreciated that as there are several sectors having identical polar diagrams a certain ambiguity exists. It is therefore necessary to have an approximate idea of the position of the aircraft so that the appropriate sector may be selected on the chart. However, these sectors are between 10 and 15 deg in width and in the unlikely event of the navigator being unable to decide with certainty which is the correct sector his doubts may be resolved by use of the A.D.F. The process of obtaining a position line takes, with practice, about a minute.

The Consol transmitter energizes an aerial system, the disposition of which results in two sectors which are of no use for navigation. The antenna array consists of three aerials erected in a straight line, the aerials being spaced three wavelengths apart. By energizing one outer aerial with current 90 deg ahead of the centre aerial in phase, and the other outer aerial 90 deg behind it, the whole of the radiated pattern is caused to rotate about the centre aerial. If the line joining the three aerials is extended the sectors bisected by this line are unusable. Generally it may be stated that only those sectors falling within the areas ± 60 deg of the median line on either side of the aerial line are of use.

Loran. A system that found considerable favour during the War, and which has since been extended to civil use, is Loran, an aid based on similar principles to the well-known Gee but having a considerably greater range. The name Loran is derived from the function of the aid, namely Long Range Navigation. While Gee is a British system, credit for the development of Loran goes to the United States.

Loran is, in its standard form, a medium-frequency aid, operating in the frequency band from 1,800 kc/s to 2,000 kc/s. At these frequencies propagation and range are subject to the ionosphere and to the question of whether the ground wave or the reflected wave is received. Generally speaking, the ground waves may be used at ranges of up to 900 n.m. by day, while at night the reflected sky waves permit reception at up to 1,400 n.m.

The system operates on hyperbolic principles, a hyperbola being the locus of a point having a fixed difference in range from two other points. (This fundamental, by the way, holds good for all hyperbolic systems.) Let us consider now the method employed in Loran to propagate a series of hyperbolic position-lines.

If two transmitters are sited at a given distance from each other they can be taken to represent the two points referred to in the previous paragraph. Now, irrespective of frequency, the speed of radio waves through the atmosphere remains constant, and is known. Thus, if the time of origin of a pulse of radio-electric energy at the transmitter is known and the time of receipt at the receiver is taken it will obviously be only a matter of calculation to establish the distance between the transmitter and receiver. And this is the precise principle upon which Loran operates.

Known as a "chain," the two Loran transmitters are located some hundreds of miles apart. One transmitter of the chain, the master, emits a number of uniformly spaced pulses each second. The second, or slave, transmitter emits a corresponding series of pulses, the two transmissions being time-locked in respect of each other. This highly accurate time-relationship is allowed for in the receiver, which is able to establish as a result the time taken for each pulse to arrive from each transmitter. An electronic computor included in the receiver measures the difference between the times taken for the master and slave pulses to reach the receiver.

It is a comparatively simple matter to plot a number of hyperbolæ for known difference-values on a chart; Loran charts are therefore prepared with the hyperbolic pattern overprinted, each hyperbolic position-line being identified by its difference-value. Accordingly, the operator of the Loran receiver merely notes the difference-reading on his indicator (which is, by the way, a cathode-ray tube) and refers this reading to his chart to obtain a position line.

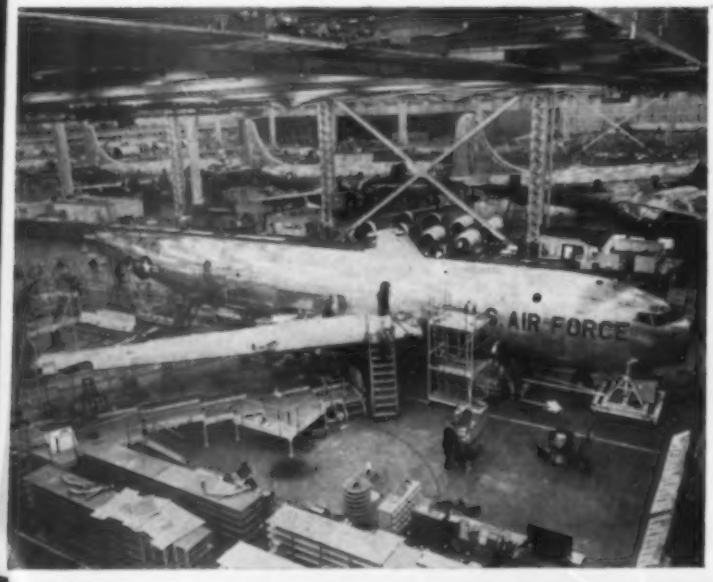
Unlike Gee, Loran provides only a single position-line. Thus, to obtain a fix it is necessary to take readings for two chains having reasonably interlocking patterns. It is usual when setting up the ground installations to try to select sites that will permit the two hyperbolic patterns to cut at a wide angle. The system allows for one station to be made common to two chains, this usually being the master.

Incidentally, unlike Consol, the accuracy of Loran does not suffer as a result of comparable ground waves and sky waves, full allowance being made for this. The accuracy of the received position-line largely depends upon the skill of the operator and other factors, but an average figure may be considered to be 1.5 n.m. at 800 n.m., using the day ground waves; at night, on sky waves, this error increases to up to about 5 n.m. The cathode-ray-tube indication, together with "blinking," provides excellent fail-safe characteristics.

(To be concluded)

THE 707 IN UNIFORM

Taken within the last few weeks in the Boeing plant at Renton, near Seattle, this is one of the first photographs to show production of the KC-135 tanker for Strategic Air Command. In many ways similar to the 707 airliner, the tanker has already been ordered to a total of at least 375. The last piston-engined KC-97s are in the background.



REPUBLIC/WESER AGREEMENT

AN agreement has been signed between Republic Aviation and the Finanz und Verwaltungs-Gesellschaft Weser of Bremen by which the West German aircraft firm will assemble and test F-84F and RF-84F aircraft before delivery to the new Luftwaffe. The American company will help in initial planning and subsequently assist in the transport, test flying and modification of the aircraft. Assembly installations, it is stated, will be planned to receive large numbers of Thunderstreaks and Thunderflashes.

"FLIGHT" PHOTOGRAPHS

MANY of the photographs reproduced in *Flight*, i.e., those taken by our own photographic staff (as indicated on publication) are subsequently available in the form of high-quality prints. Prices are as follows (dimensions given in inches): 5½ × 3½, 1s 4d (glossy or semi-matt, unmounted) or 2s (toned sepia, unmounted); 6 × 4, 2s 6d or 4s; 8 × 6, 3s 6d or 5s 6d; 10 × 8, 5s or 7s 10d; 12 × 10, 6s or 9s 8d; 15 × 12, 9s 6d or 13s; 20 × 16 (semi-matt only), 13s or 18s.

Also available are a postcard series, totalling over 200, depicting both historic and modern aircraft of the R.F.C., R.N.A.S., R.A.F. and Fleet Air Arm. Complete lists of the series are obtainable on application. Prices are 8d each card, or 7½d each for quantities of a dozen or more. One view only—in most cases a good three-quarter front or side—is available for each aircraft type. Also available as postcards, at the same prices, are reproductions of general-arrangement drawings of some 20 British aircraft that have appeared in our "Aircraft Intelligence" pages.

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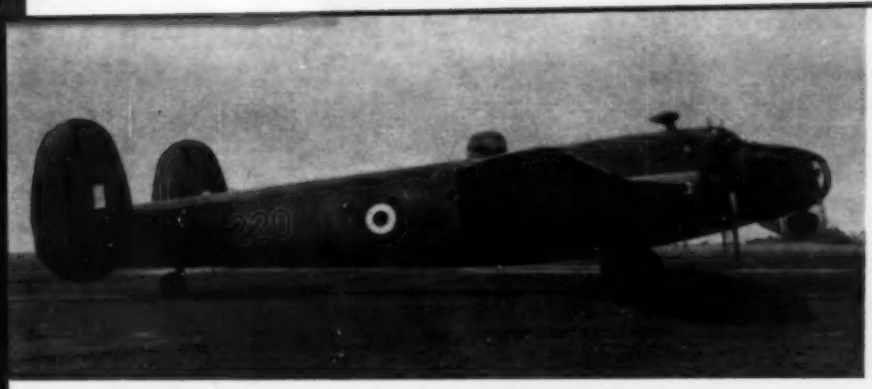


An Avro Shackleton M.R.1 of No. 220 Squadron, R.A.F. Coastal Command. Allusion is made to this aircraft in the first paragraph on this page.

AIRCRAFT INTELLIGENCE

Great Britain

Coastal Command Markings. Aircraft of R.A.F. Coastal Command now carry the squadron number on the fuselage side, in the manner initiated by No. 228 Squadron, for its tour of South America late last year. On this page is a picture of a Shackleton M.R.1 of No. 220 Squadron so marked. The number and the individual letter on the nose are in bright red with a white outline. Neptunes of No. 36 Squadron, based at Topcliffe, have their markings in green, with white outline. No. 42 Squadron (Shackleton M.R.2s) is another unit which has adopted the new system.

U.S.A.

North American F-100. Under development by Flight Refuelling, Inc. is a "buddy system", which will enable an F-100 to refuel from another Super Sabre. The "buddy" machine will trail a hose and drogue from an under-wing pod, similar in contour to a normal auxiliary tank. Upon completion of refuelling the entire equipment will be automatically rehoused.

Douglas A3D Skywarrior. First deliveries of Skywarriors have been announced by the U.S. Navy. Five of these twin-jet carrier-borne bombers have been ferried to Jacksonville, Florida, to form the first heavy attack squadron, VAH-1.

Douglas AD Skyraider. The U.S. Navy has accepted delivery of the 3,000th Skyraider from Douglas's El Segundo Division. On the occasion of the delivery it was disclosed that Skyraider production will continue into 1957. Both the AD-6 and AD-7 single-seaters are concerned and deliveries of the -7 model should begin in August this year. The -7 is the 50th version of the "Able Dog" series since the prototype flew in March 1945.

Canada

Canadair CL-28. Production of this maritime-reconnaissance development of the Bristol Britannia, powered with Curtiss-Wright Turbo-Compound piston engines, is on schedule. The first machine of the initial batch of 13 should reach the final assembly line in September, be out of the hangar in November, and ready for flight-test early next year.

France

French Production. At a recent press conference M. Henry Laforest, Secretary of State for Air, disclosed that "in view of the present political requirements" a special effort is to be made in the production of certain French aircraft. For example, production rate of the Max Holste Broussard utility transport and the S.E. Alouette helicopter is to be increased. A similar effort is going into the production of Dassault 315s and the modification of Dassault Ouragans to "Barougan" standard, which includes paired-wheel landing gear for operations from unprepared strips.

French Orders. M. Laforest has also disclosed these orders for French aircraft: Mystère II, 150 ordered, 40 delivered; Mystère IVA, 325 ordered, 128 delivered; Mystère IVB.2, 150 ordered (this to be increased to 370), delivery to begin in 1957; Vautour A, B and N, 140 ordered (to be increased to 360), deliveries to begin in the second quarter of 1956; Nord 2501, 160 ordered (to be increased to 200), 90 delivered; Bréguet 765, 15 ordered, deliveries to begin in 1958; Fouga CM.170, 95 ordered (to be increased to 325), deliveries to begin in second quarter of 1956; Max Holste 1521, 198 ordered (to be increased to 310); Morane Saulnier 733, 130 ordered (including 60 with armament), 70 delivered; Morane Saulnier 760, provision made for ordering 50, deliveries to begin at the end of 1957; S.E.3130, 100 ordered, deliveries in the second quarter of 1956; S.O.1221, 100 ordered (including 60 for the Army), delivery rate four monthly, 35 to be delivered by the end of 1956.

HANDLEY PAGE VICTOR B.1
(production type)
(Four Armstrong Siddeley Sapphire)

Span	110ft
Length	114ft 11in

Fig. 1. The best known of all accident investigations was that carried out on the Comet in 1954. The picture shows the three-dimensional reconstruction of wing components.

Mr. E. L. Ripley's R.Ae.S. Lecture Summarized

THIS paper, by the head of the accident investigation section of the Royal Aircraft Establishment, was read before the Royal Aeronautical Society on April 17th. Reproduced here, in summarized form, the lecture deals with a most important aspect of accident investigation—the analysis of wreckage. It provides fascinating reading for those who, in the author's words, "look at a heap of wreckage with dismay."

Aircraft Accident Investigation

"I DO not intend," the author began, "to go over again the ground which has already been covered. I am going to deal with what can be learned from wreckage." The evidence of eyewitnesses, he said, even of the aircraft's crew, could be faulty and inaccurate, but the evidence in the wreckage—if it could be interpreted—was a sure and certain guide. Its investigation, when properly done, was a scientific and logical process.

The first point to be noted at the site of the accident was in what attitude the aircraft struck the ground. The general layout of the wreckage and the impact marks would show whether it struck at high or low speed, whether it was drifting sideways, or perhaps spinning. Local damage to trees or buildings might give valuable information as to what the aircraft was doing in the last few moments of flight. It was essential during the preliminary examination that every part of the machine should be accounted for, and if necessary a search should be organized. Knowledge of the disposition of wreckage could be a valuable asset to the investigation, but this had to be done quickly, as would-be helpers, in bringing fragments to the main site, often forgot whence they came.

After plotting the disposition of wreckage on a large-scale map of the area, the next step was to take a closer look at the fragments. A copious series of photographs was always valuable here, although such important details as the position of cockpit controls and the readings of instruments should always be jotted down in a notebook. In the author's view the detailed investigation should not be conducted on the site, but the wreckage should be taken where it could be handled with better facilities. To deal carefully with wreckage was absolutely vital. It would not be amiss to attach a label "Handle Like Eggs" lest vital evidence were obliterated.

Once the wreckage had been brought back to the hangar, the first task was to rebuild it, although sometimes circumstantial evidence indicated that only a part need be rebuilt. The author illustrated an example of wreckage-rebuilding familiar to everyone—that of the Elba Comet; one of his illustrations is reproduced in the heading. The work which was performed on the remains of this aeroplane was typical of that done following any major accident of which the cause was obscure. The best way to reconstruct wreckage was to do it three-dimensionally, on frameworks; the aircraft was often laid out on the floor of the hangar in order to sort out the pieces before they were put on the framework.

Piecing together the jigsaw puzzle was not as difficult as it might appear. The aircraft's colour scheme provided an important clue, and one soon learned to look for identifying features such as access doors, drain holes, and so forth. Skin gauges, which varied all over the aircraft, enabled wreckage to be sorted into groups, and a useful guide was the angle or distance between rivet lines caused by taper or sweepback.

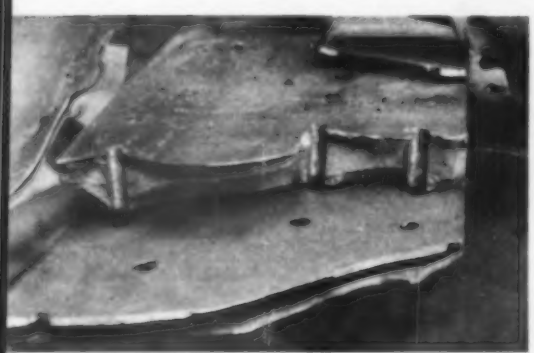


Fig. 2 (left). Tension failure in a spar boom: This is actually the tension part of a spar failure in bending, but the loading is predominantly tension and exhibits the typical "angles" of a tension failure.

Fig. 4 (below). A good illustration of a "fir tree" pattern, showing how the failure had developed from the top.

Fig. 3 (below). Bending failure of a light alloy lug: Note the tension failure and the characteristic "fir tree" pattern, helpful in tracing the origin of a failure. (See also Fig. 4, right.)

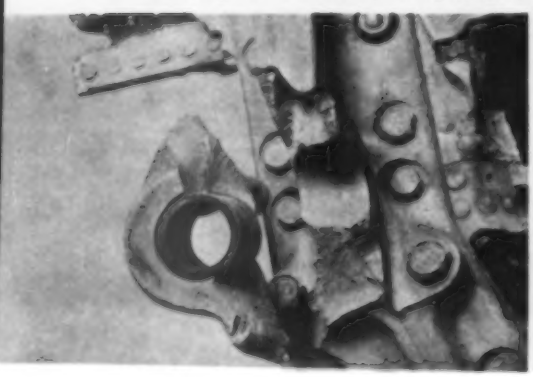
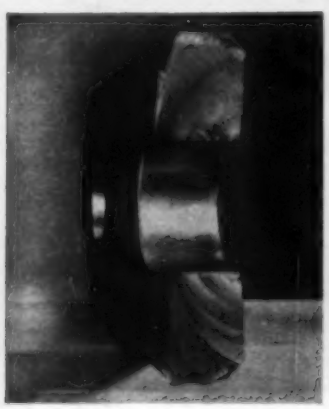


Fig. 5 (below, right). This example of a fatigue failure of a steel lug shows the characteristic surface of the fracture and progression lines.



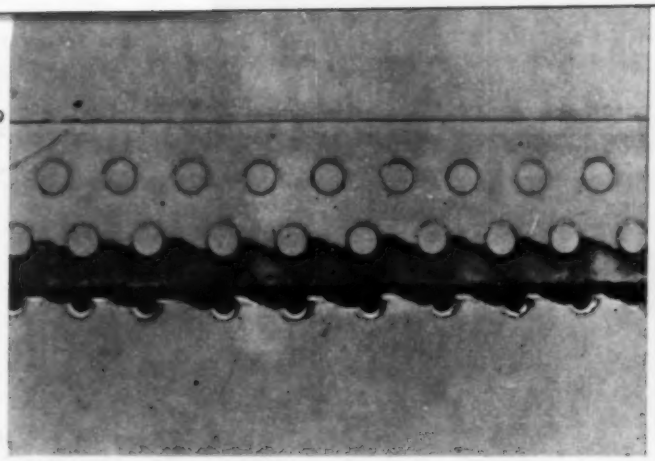


Fig. 6. Rivet joint failure: In this case there was tension across the fracture, and the characteristic shape of the failure gives the progression.

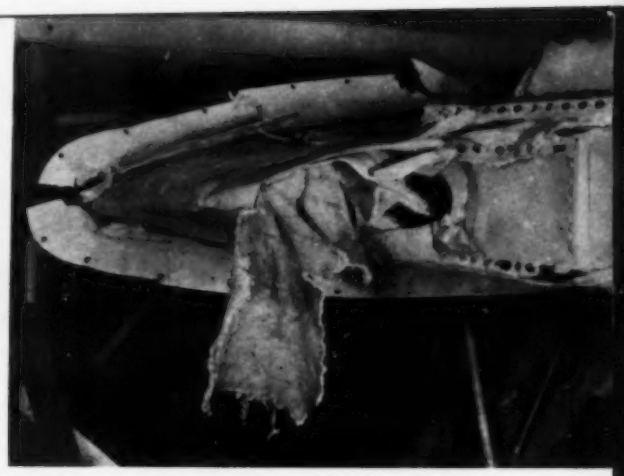


Fig. 7. The presence in the tailplane of a piece of carpet proved the tail to be on when the fuselage failed.

The author turned next to what could be learned from the finer details of the wreckage, dealing with the subject in two parts: fracture analysis, and "sequence" analysis.

The principles upon which fracture analysis was based were simple, but experience was needed in applying them. Each basic type of fracture, such as tension, compression, shear or fatigue, had certain characteristic features which could be recognized. The author illustrated a number of different types of fracture (Figs. 2-3) One was a tension failure in a spar, showing the typical "angles" familiar in the normal tension-test-specimen, where they are referred to as "cup-and-cone" failures. Figs. 3 and 5 show the bending failure of a light alloy lug and a fatigue-failure of a steel lug. A good example of a rivet joint failure is seen in Fig. 6.

Recognizing a fracture was, however, only a means to an end. It had been shown how fractures differed, and by studying various detailed signs the direction of progression of a failure could be determined to enable the primary failure to be found from a sequence. The process of adding up detailed information followed principles of deduction that applied to all wreckage analysis.

In some complex examples it was often necessary to consider the paths of the loads required to produce failure. Thus it might be deduced that one failure must take place before or after another, so that the necessary load could be transmitted. Again, by examining the relative deflections of the parts, a sequence might be deduced. The author recommended the making of diagrams on which could be recorded all the details of the fractures and other evidence such as scratches or impact marks.

As far as the equipment used in fracture analysis was concerned each investigating officer had his own pocket magnifying-glass, ranging in power from five to ten times magnification. For microscopes the prism binocular was favoured, as it gave a stereoscopic picture and not a reverse image; both low-powered and high-powered types were used; in addition, all kinds of devices for seeing around corners were employed, ranging from mirrors to intrascopes.

Fracture analysis revealed how the various parts failed, but the most vital fact to be established was which failure was the true primary. This was often a much more difficult job, involving prolonged searching of the wreckage. The task was one of elimination. A wing failure could be shown to precede a tail failure, for example, by evidence that the wing struck the tail before the latter was detached.

The author showed some illustrations of damage by impact—one of the most useful indications in the derivation of sequences. The first was of the Elba Comet's tailplane; as the wreckage was being assembled it became clear that there had been a failure

Fig. 8 (right). One of the most curious impact marks ever discovered—the imprint of a one-anna piece in the tailplane of the Elba Comet.

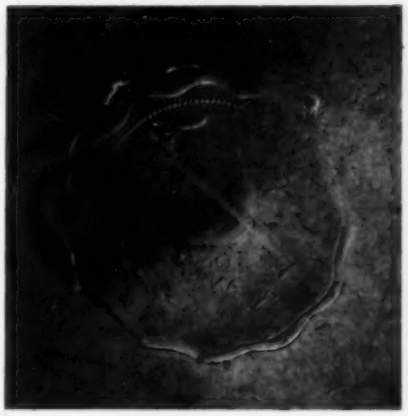


Fig. 9 (below). Another example of impact evidence: an unusual mark on the fin was shown to have been caused by a piece of fuselage with the aerial attached (inset).

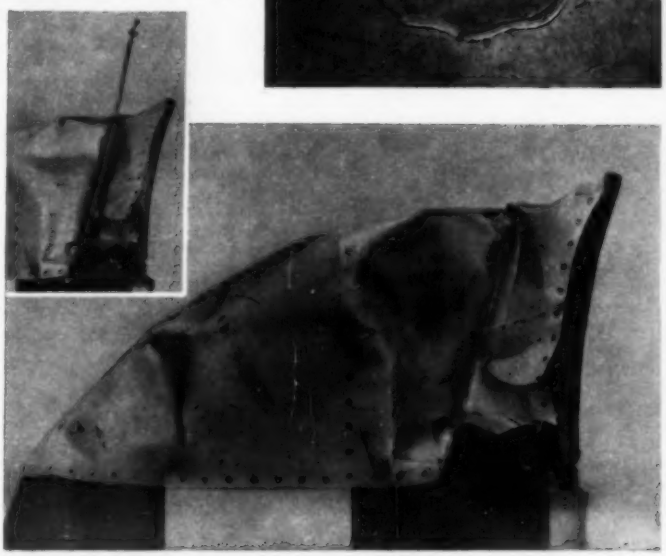


Fig. 10. The mark of a rotor-blade is clearly seen in this picture of a portion of helicopter fuselage.

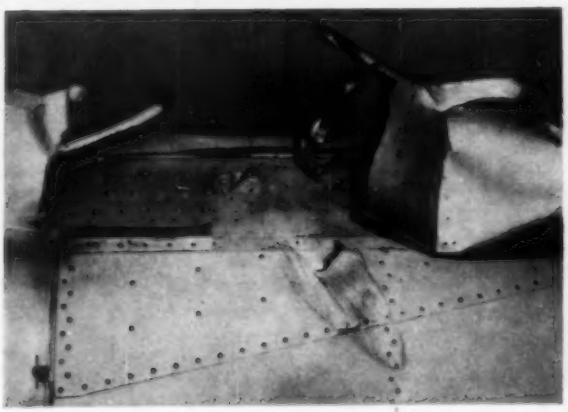
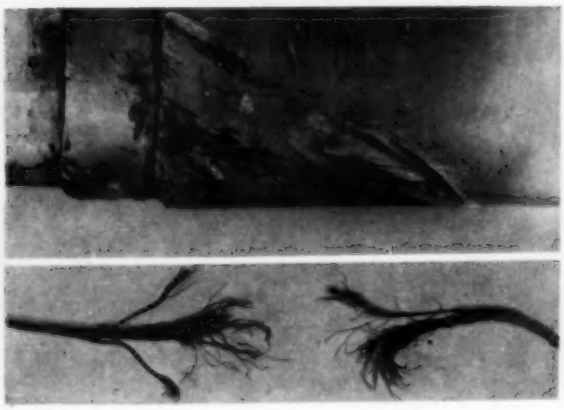


Fig. 11. Here a helicopter blade has cut through two cables, leaving a clear impression on itself.



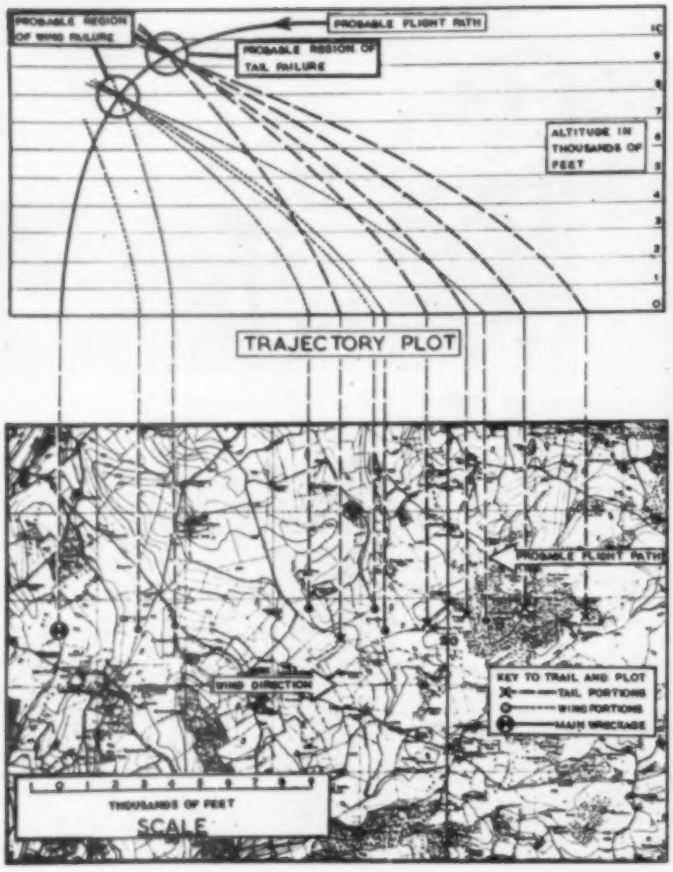


Fig. 12. Trajectory plotting: In this illustration wind drift only has been considered, but plotting must allow for the forward speed of falling objects. This method is a most useful tool provided its limitations are clearly understood.

Fig. 13. An instance of tearing at the end of the slot of a control mechanism, which was obviously caused by a failure elsewhere.

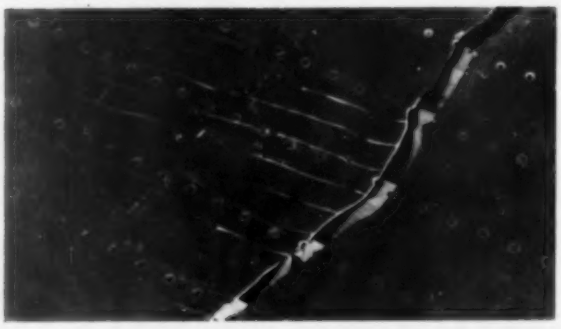


Fig. 14. The parallel nature of these scratches suggested that they were caused by rivet heads, and from their pitch it was possible to trace the identity of the striking object. It was clear, too, that the scratching took place after the fracture.

AIRCRAFT ACCIDENT INVESTIGATION . . .

in the air on the port side, and that the outer portion had separated by downward bending. At the same time it was known that the wings also had failed in a similar way. Experience had frequently taught that if an aircraft lost its tailplane it bunted, causing down-load failure of the wings. Here, then, was a possible "primary" for the Comet accident: the other failures, such as the bursting of the fuselage, might have resulted from the additional strains imposed by the break-up. The wreckage, however, provided a different answer. Detailed inspection of the port tailplane revealed a series of blue impact marks outboard of the main break, and these were shown by chemical analysis to have been caused by one of the blue-painted cabin seats. Thus fuselage failure had preceded tailplane failure. That was not all, however; when the detailed fractures were traced back to their origin it was found that the main failure of the tailplane had been caused by the impact of a heavy portion of structure. In doing so it left its trade mark—a piece of fuselage carpet (Fig. 7). With this double assurance the possibility of tailplane failure as the primary cause of the accident was confidently eliminated.

Impact marks were a very fruitful source of information, said the lecturer, who gave further illustrations (Figs. 9 to 11) of typical examples found in practice. Not all impact marks occurred in the air, and it needed a skilled investigating officer to distinguish between air damage and ground damage. Fig. 15 provided an obvious example of ground damage. Control movements and positions could also be vital evidence. Fig. 13 showed the over-riding of a control lever in its slot: clearly a failure elsewhere must have allowed this to happen, and by tracing such damage back the primary failure could often be located. The author warned against assumptions being drawn from the position of control surfaces, pointing out that it was important to look for evidence giving the control's position at the time of failure.

Scratches were another profitable source of information. Fig 14 was an example, clearly showing that fracture must have occurred before the scratches were made. Sometimes fragments of material were lifted by the scoring objects, thus giving the direction of the score. To illustrate examples of how "sequence" evidence could be provided by small components as distinct from structure, the author showed two photographs: a piston-engine valve with an impact mark corresponding to another on the crown of the piston, giving evidence of overspeeding; and two halves of an airscrew constant-speed unit, yielding evidence that the gears were not revolving when the unit received a blow. Examination of hydraulic and electrical equipment and the fuel systems could, from a mark here or a mark there, reveal the story of what happened.

Clothing should be most carefully examined. The speaker did not want to be gruesome, but pointed out that vital clues might

(Continued at foot of page 502)

Fig. 15. It is always necessary to distinguish between air damage and ground damage; these two pictures constitute an obvious example of the latter.

High-speed Experimental Flying

Col. C. E. Yeager Relates his Experiences to the R.Ae.S.: Rocket-propelled Research Aircraft from the Pilot's Angle

Col. Yeager—a photograph taken on the evening of the lecture.

SPEAKING at a "main" lecture meeting of the Royal Aeronautical Society, held at the Institute of Civil Engineers, London, on Thursday of last week, Lt-Col. Charles E. Yeager, U.S.A.F., gave an excellent account of the experimental flight-testing programme carried out at Edwards Air Force Base on the series of rocket-propelled research aircraft. (He was himself selected to carry out the experimental flying of the Bell X-1—then called the XS-1—in 1946, and afterwards flew its successors.)

After introduction to a distinguished audience of designers, technicians and test pilots by Mr. N. E. Rowe, president of the R.Ae.S., Col. Yeager went straight into his story. He had told it many times before and one gathered that his audiences had too-often been interested in the spectacular rather than the technical aspect of his experiences, and that they had required simple explanations of such terms as "Mach number"; but in view of Britain's limited experience of high-speed rocket-propelled flight, the visitor may not have been too far wide of the mark in "talking down" a little to this audience.

In fact, he gave a simple account of the aircraft he had flown in the high-speed-research programme in America. It was known during the war, he said, that the Spitfires, Mustangs and Me109s then in action encountered curious aerodynamic phenomena at their highest diving speeds. The U.S.A.F. had therefore ordered in 1943 a straightforward aircraft for research in these speed regions. Because of the lack at that time of a suitably powerful jet engine, a Reaction Motors Inc. rocket motor with four barrels, each giving 1,500 lb thrust and using the comparatively well-known liquid oxygen and alcohol fuel combination, was chosen for the powerplant. Independent take-off without a "mother-ship" was at first desired.

The "hardware in flyable condition" was delivered to the U.S.A.F. in 1946 in the form of the Bell X-1 and, because it was small, it was handed over to the fighter development section. According to Col. Yeager, straws were drawn to choose the pilot and he drew the short straw. Some 20 flights in the makers' hands had proved the machine airworthy, but endurance was too short to allow independent take-off and climb, so the bomb-bay of a B-29 was cut to shape and fitted with a plain B.7 bomb shackle, picking up on a lug on the X-1. The scheme was to drop the X-1 at 30,000ft, so allowing it to start straight away on its test runs.

The X-1 was stressed for 18g positive and 10g negative. It had a straight wing of 8 per cent thickness/chord ratio and entirely mechanical controls, with no form of boost. The tail-plane incidence was variable through a screw-jack. It carried 288 gal of "lox" (liquid oxygen) and 300 gal of five parts alcohol and one part water mixed. This was fed to the motors by pressurizing the tanks from a 5,000 lb/sq in reservoir of water-free gaseous nitrogen, which was also used to actuate the pneumatic flaps and undercarriage mechanisms, turn the gyro flight-instruments and pressurize the cockpit. The pilot remained cool (or cold) because he leant against the lox tank. The 5,000 lb/sq in pressure was raised by allowing liquid nitrogen to boil off into the reservoir. No mechanical pump could at that time achieve that pressure.

The machine was backed down into a pit and winched up into the B-29's bomb-bay. The pair was moved over another pit for fuelling. For full-load take-off Yeager sat in the B-29, since this climbed at 180 m.p.h. and the X-1's stalling speed was then 240 m.p.h. Had anything gone wrong he would have been poorly placed had he been inside the X-1. At 10,000ft he would climb down a ladder, exposed to slipstream, and fasten himself into the X-1 cockpit. At 25,000 he had the tanks pressurized and was ready to go at about 30,000ft. After each test run all remaining fuel was jettisoned and a dead-stick approach was made to the 13-mile-long lake-bed runway. This gave no trouble; he arrived overhead at 5,000ft and over 300 m.p.h., made his checks and turned at 220 m.p.h., "crossed the hedge" at 200 m.p.h. and touched down at 180 m.p.h. The first three flights he made were without fuel or power, for familiarization—some turns and stalls from 15,000ft. It was dark inside the B-29's bomb-bay, and when he was released into the bright sunlight he was blinded for two or three seconds. Powered research runs were then started.

The individual rocket barrels could be switched off and on at will as long as fuel lasted (about 3.5 min). A camera filmed the pilot's instrument panel over his shoulder and a 15- to 20-channel telemeter radioed data on pressures, loads and control-surface positions to receivers on the ground. Each flight was made according to a carefully planned programme, and Yeager first took the X-1 to 40,000ft and went to Mach 0.87. The second run went to Mach 0.89 and experienced buffeting and a wing-drop which it took one third aileron to hold. To explore the effects of higher Mach numbers he then banked and raised the C_L by pulling back the stick. The third flight went to Mach 0.91-0.92 with slightly greater effects. It was on the fourth flight that he first banked and found the elevator ineffective for turning; but by moving tailplane incidence ¼ deg down he achieved a 2g turn. The shock-wave was measured as having moved back across the tailplane to the elevator hinge line, blanking off the elevator. From this came the American decision that only the all-flying-tail system, with the tailplane moving under direct control of the stick, could give adequate transonic manœuvre control. Plain V.I. was effective, but not quick enough.

The sixth flight was made in 1947, and a speed of Mach 1.04 was reached—the first supersonic flight. Altogether some 80 flights were made with the X-1 and a maximum speed of Mach 1.5 reached at 46,000ft, and a maximum height of 70,000ft. Some fires occurred, and pieces of the airframe were lost at various times, but the aircraft's research capabilities were used to the full and the airframe was given to the Smithsonian Museum for preservation. Data gathered were issued to all the aircraft constructors. Some other research had been done with the X-1, and the T-1 partial-pressure suit had been developed to cope with cabin pressure failure. There was no ejector seat and the pilot was expected to crawl out through a small door for emergency escape. Yeager wore a parachute, but said it was for comfort more than anything else.

The last X-1 flight was in 1949, when the tanks were half filled and the machine was "drug off to the southern end of the lake bed" to make an independent take-off. It achieved what would even now be classed as a very high rate of climb indeed.

The next project Yeager was involved in was the evaluation of the Northrop X-4, which was similar in layout to the D.H.108 semi-tailless aircraft. This was taken up to Mach 0.94 in 1949 and its characteristics assessed. After that came the X-5 variable-sweep aircraft used for Mach-drag research. It reached Mach 0.82 straight-winged and Mach 0.94 with 60 deg sweep. Its gust load stability characteristics and other data were obtained.

By this time the other X-series aircraft came along. The X-1-2 was a thicker-winged version about which Yeager said nothing. The X-1-3 was a refined X-1 with a new pump system allowing lighter tanks and greater fuel capacity. Turbine pumps were driven by 90 per cent hydrogen-peroxide passed over a "catalyst crystal" to produce steam. It carried 500 gal of lox and 550 gal of alcohol mixture giving a power endurance of 4.5 min. The engine was tested and the X-1-3 was taken by B-29 to 30,000ft. There it was found that all the nitrogen for systems operation had leaked away and at 10,000ft on the way down there was an explosion and the pilot climbed rapidly back into the mother ship. The X-1 then caught fire and was jettisoned.

In November 1953 the X-1A was delivered. It had 7ft more fuselage, the new pump system and other refinements. It was decided that this should be taken to Mach 2 before the 50th anniversary of powered flight on December 17th, and a programme of four flights to this end was prepared—not without some misgivings. Flights were planned to give a preset flight-path with a certain climb and "push-over" into level flight for the speed run. The aircraft was dropped at 30,000ft; three barrels were lit. It was accelerated to Mach 0.8, climbed to 45,000ft, and the fourth barrel was lit, giving an acceleration in the climb to Mach 1.1. The first three flights reached respectively Mach 1.3 at 45,000,

HIGH-SPEED EXPERIMENTAL FLYING . . .

Mach 1.5 at 60,000, and Mach 1.9 at 60,000ft, giving a final T.A.S. of 1,200 m.p.h. On December 12th (five days ahead of the ordered time) the great flight was made. Acceleration and climb were routine up to 60,000ft when the "push-over" was begun and speed rose to Mach 1.4. At 70,000ft the X-1A was more or less level at Mach 1.9 and accelerating at 31 m.p.h. per second. It reached Mach 2.5 at 76,000ft—a T.A.S. of 1,650 m.p.h. and I.A.S. of 440 m.p.h., accurately measured. The aircraft had achieved an induced stability through acceleration when, at this point, fuel ran out and all four barrels cut instantaneously. All stability disappeared in the sudden deceleration and Yeager lost control as the X-1A tumbled wildly. In a matter of seconds he found himself at 25,000ft and 170 m.p.h., the aircraft having, amongst other things, pitched-up to 11g and been brought (by Yeager) out of an inverted spin. Side loads on the fuselage had been two-and-a-half times those specified as the design limit, but the aircraft remained intact.

This was Col. Yeager's last flight in the X-1A, and it is very firmly impressed on his memory. Since then, he said, the aircraft had been taken to 90,000ft by other pilots, but kept below Mach 2.0. Research on this and other machines of similar type was continuing. One of the X-1As blew up while being carried in the "mother ship" and was jettisoned at about 30,000ft some six months ago.

Col. Yeager indicated that at their current speeds the X-1s were up against the thermal limits of the metals of which they were built, and that should they remain at those speeds for five or ten minutes they "would begin to lose pieces" through skin-friction heating. [The wing of the Douglas X-3, a U.S. Navy project, is of stainless steel and the long nose cone is cooled by fuel circulated close to its skin.]

The X-2, said the speaker, was a more refined aircraft, with three times the power of the X-1 (i.e., 18,000 lb thrust) and swept stainless-steel wings. Discussing the swept wing for this type of flying, Col. Yeager mentioned the difficulties experienced with the Douglas D-558-2 Skyrocket (a U.S. Navy project) in the "push-over" phase, where it had met instability troubles. The straight-winged X-1, he said, had met none of these troubles; neither did it suffer any longitudinal trim-changes at transonic speeds.

The speaker went on to review some of the physiological problems of the "zero g" condition. Certain organs of the body, he said, depended on more or less normal positive g for their proper functioning. In prolonged "zero g" states, therefore, some positive gravity effect would have to be simulated, and this could be done in a space vehicle by rotating the cabin and producing a centrifugal force equivalent to gravity. This would allow the occupants to stand "normally" on the walls.

Friction heating was now being tackled and the use of ceramic coatings was likely in future aircraft; but one of the principal problems lay in providing efficient safety devices to save the pilot should an emergency arise at the speeds and heights now envisaged.

When Col. Yeager had completed his story, Sir Sydney Camm, director and chief designer of Hawkers, took over the meeting and called on Mr. Peter Twiss to start the discussion. The Fairey Delta 2 test pilot said that we in Britain lacked the instruments, particularly horizons and Machmeters, to give the pilot the information needed to make really precise high-speed flights. Yeager replied that he had found an inclinometer useful for keeping correct climbing angles, but that difficulty had arisen through instrument lag caused by the length of dynamic pressure sensing lines. Some electrical transmission of sensed pressures was required.

Neville Duke, Hawkers' chief test pilot, then commented that this country lacked facilities for high-speed research: nor, during the war, had we the spare resources for this type of work. Today we had not the research lead on design to be able to evolve such aircraft. So far as he knew we had only one aircraft with rocket power [the Hawker P.1072] and that had only made some six flights, in 1948 or 1949. Indicated speeds of 800kt were not far off and something had also to be done about pilot survival: he did not consider the ejector seat adequate. It was unfair to ask the pilot to fly without such safety equipment.

G/C. R. G. Slade, Fairey chief test pilot, said that it was astonishing what had been done in America at speeds still beyond our reach. Some system of progressive power reduction at high speeds was needed, he continued, to avoid instability such as had been found in decelerating the X-1A. Col. Yeager observed that the deceleration caused by cutting out only the afterburner of such types as the F-100 and F-104 had a considerable effect on the pilot's sense of balance, particularly during instrument flight. The X-1A had, however, suffered no longitudinal trim changes during transonic and low supersonic flight.

Mr. George Edwards, managing director, Vickers-Armstrongs Aircraft Division, observed that, however hard and damaging to his health the designer or technician might think his work to be, he should remember that it was only the test pilot who actually exposed himself to personal danger. This should never be forgotten, nor should any chance be missed of seeing that he did not come to an untimely end. After moving a vote of thanks to the test pilots for their work he concluded, in lighter vein, that the flying saucer of tomorrow might well be made of the same material as the one "our tea is in when we fan it with our hats."

Mr. E. T. Jones, president-elect of the R.Ae.S., remarked that he had heard Col. Yeager say on a previous occasion that the pilots of the X-type research aircraft had insisted that, for simplicity's sake, cockpit instruments should be reduced to the absolute minimum. This was all very well in the 365 days-per-year sunshine over the Mojave Desert, and when 13 miles of runway were available; but with a 2,500-yd by 100-yd runway and frequent poor weather how could instruments be reduced? Nevertheless, was there not a case for making aircraft less comprehensive and more simple? Col. Yeager observed that many U.S.A.F. aircraft were penalized by being equipped for several different rôles, and that pilots did not appreciate the extra complication of dual purpose when only one type of mission was in any case being practised.

The lecturer was then asked for his opinions of the Russian Mig-15, which he had flown in Okinawa; but he said that the evaluation was made to check the accuracy of American intelligence estimates, rather than to evaluate the Mig-15 in comparison with corresponding American aircraft. The results were therefore "classified."

To another question, he replied that he had felt no effects from skin-friction heating in the X-1, since he was not anywhere nearer than six inches to the outside skin, and because he was very close to the lox tank, which was extremely cold. He wore a T-1 partial-pressure suit and a very heavy flying suit on top of it. The heating limit would first have been reached by the Plexiglas cockpit canopy, and its inner liner had in fact been removed, but this was rather to prevent it impinging on the pilot's head than to alleviate heating effects.

Of dead-stick landings in the X-1, Col. Yeager said that such approaches had been extensively practised in F-86s, but that aircraft now coming into service would be extremely difficult to land without power. He would not advise any but an experienced pilot even to attempt it. Questioned about the problems expected in the projected X-10, reported to be designed for speeds of Mach 10, he said the main problems would have to do with heating rather than plain aerodynamics.

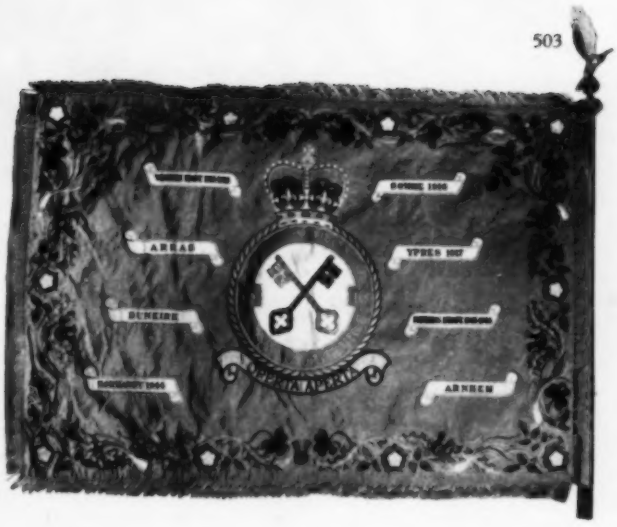
When the meeting closed Sir Sydney Camm expressed his gratitude to test pilots, saying that, if weight was to be reduced in aircraft, it should never be reduced at the expense of proper safety equipment and comfort for the pilot.

AIRCRAFT ACCIDENT INVESTIGATION (continued from page 500)

be lost if this was not done. The principles of the examination were the same—examine every minute detail and find a reason for any abnormalities.

In addition to examination for direct evidence of sequence, there was another method which sometimes proved useful in determining the succession of major failures. This was "trajectory" plotting. With knowledge of local wind conditions and the falling characteristics of the pieces, it was possible to plot a trajectory of a piece from any point to the ground. A picture could then be formed of the way in which the aircraft broke up (Fig. 12).

Summing up, the author said he had tried to show that there was evidence in the wreckage which, if rightly interpreted, can in conjunction with circumstantial evidence provide the answer. He had tried to show too that the interpretation of wreckage was not a deep mystery. The facts were there and they had to be found and understood. They were practical and were capable of practical solution. It needed experience to recognize details and tremendous patience to search for them. A vast amount of self-control was needed, since it was easy to jump to a conclusion from limited evidence, particularly in accident work under the stress and urgency of the moment. Different explanations probably satisfied several of the conditions of the accident, but it was necessary to find one which would satisfy them all. The lecturer firmly believed that evidence from the wreckage and the circumstantial evidence, taken together, could in the majority of cases provide that answer. Sometimes, he admitted, the complete answer could not be found, but perseverence was rewarded in the majority of cases. There was a path of careful investigation and logical deduction which could lead to the answer, and it was not necessary to traverse that path by means of a crystal ball.



The Standard shows the Squadron's crossed keys emblem and the motto, "Operta Aperta" ("Hidden Things are Revealed"). The battle honours are Western Front 1915-1918, Arras, Somme 1916, Dunkirk, Fortress Europe 1943-1944, Normandy 1944 and Arnhem. The squadron is now with 2nd T.A.F. in Germany.

No. 16 SQUADRON

A 2nd T.A.F. Fighter/Bomber Squadron Receives its Standard: Some Past Achievements Recalled

ON April 6th the Duchess of Kent, on a tour of military units in Germany, flew through a snowstorm to present a standard to No. 16 Sqn. at Celle. Under its Commanding Officer, S/L. G. G. G. Walkington, the squadron staged a parade which drew praise from German observers. The occasion was photographed, televised, filmed and radio-commentated.

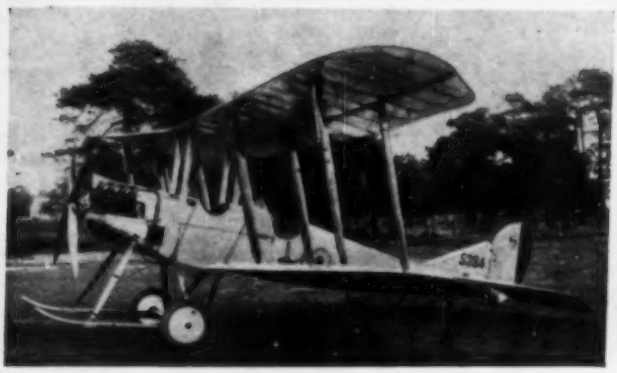
Among the 300 squadron members and guests present were the British Ambassador, Sir Frederick Hoyer-Millar, the C-in-C. 2nd T.A.F., Air Marshal the Earl of Bandon, and the Air Officers Commanding Nos. 2 and 83 Groups. Her Royal Highness toured the squadron installations, met members of the squadron and their families, inspected a Venom and took lunch in the mess with the officers, their wives and many old members who had come over for the occasion.

Operta Aperta ("Hidden Things are Revealed") has been the squadron motto now for twenty years, and has been the inspiration and key to success since its formation at St. Omer, in France, on February 10th, 1915. The nucleus of the unit was formed from detachments from Nos. 2 and 6 Squadrons and, shortly afterwards, the addition of a flight from No. 5 Sqn. brought it up to something approaching full strength as a fighting squadron.

The first of many successful commanders was Capt. F. V. Holt, D.S.O., under whose leadership the first operational sorties were flown on February 26th, 1915. They were tactical reconnaissance flights for the Army, and marked the beginning of many years of army co-operation. Although the squadron initially received its orders direct from Army headquarters, it was soon transferred to No. 1 Wing, which at that time was commanded by Lt.-Col. Trenchard (as he then was), who controlled the R.F.C. units operating for Gen. Sir Douglas Haigh's First Army. No. 16 Sqn. was using a variety of reconnaissance aircraft, and it did much fine work in photography, artillery observation and patrols. Shortly before the battle of Loos, Major H. C. T. (now Lord) Dowding took over command and was relieved by Major C. F. (now Lord) Portal in June 1917. One month earlier the squadron had been re-equipped with the R.E.8.

It was an aircraft of No. 16 Sqn. which flew the Armistice patrol—the last patrol of the war. From this flight Capt. H. L. Tracey (pilot) and Capt. S. F. Davidson, M.C. (observer) landed at 11.45 a.m. and reported as follows: "No enemy activity. Our

No. 16 Sqn. was formed in February 1915 from flights detached from Nos. 2 and 6 Sqns. Soon afterwards a flight from No. 5 Sqn. was added. Some of the first types of aircraft used were the Blériot monoplane, R.E.5, (and below) Vickers "Gun Bus" and B.E.2c.



Squadron officers at Beaupré Farm, La Gorgue, in June 1916. Only surnames are on record, and they are as follows (left to right):—
Least, Owles, Buck, Howell, Minot, Budgen, Davidson, Davidson, Maj. Powell, Diamond, Shaw, Ellis, Nesbitt, Pentland, Waller, Trascott, Waddington and Welsh.

Three of the squadron's Hawker Audaxes caught by "Flight's" cameraman in the Old Sarum area in 1935.

NO. 16 SQUADRON . . .

troops in Mons. A.A. fire nil."

Disbanded on December 31st, 1919, the squadron was re-formed as No. 16 (Army Co-operation) Squadron on April 1st, 1924, under the command of S/L. J. O. Atcher, C.B.E. Based at Old Sarum, it was first equipped with Bristol Fighters and then with A-W. Atlas (1933), Hawker Audax (1935), Hector, and Lysander (1939). It spent altogether fifteen peaceful and happy years on Salisbury Plain, training in tactical reconnaissance, photography, gunnery and bombing, and taking part in exercises with the Army.

During the "phoney war" of 1939 the squadron stayed out of action, so the tempo of training was stepped up. Then, in February 1940, it moved to Hawkinge and in April went over to France. The battle there, when it arrived, was short and fierce; and within three weeks of the German invasion of the Low Countries the squadron was back in England. Several successful reconnaissance and bombing missions had been accomplished, but the squadron had lost one-third of its aircraft and aircrew to German fighters and flak. F/L. Yorks won the D.S.O. for his leadership in operations and in bringing the remains of the squadron home, and F/L. Dudgeon and F/L. Rust each won the D.F.C. for their exploits.

During the Battle of Britain No. 16 Sqn. were forced to take a back seat. Their Lysanders, naturally, did not have the height, speed or fire-power necessary to counter German fighters or bombers. The squadron was therefore used for daily dawn and dusk reconnaissance of the beaches against invasion. Each night all aircraft, even the Tiger Moths, were bombed-up in readiness to attack German troops should they land on English beaches the next day. Base was moved frequently during these months—to Redhill, Cambridge and Okehampton—but the rôle remained the same.

In October 1940 the squadron moved from Okehampton to Weston Zoyland, where it was to remain for the next two years; and during that winter and throughout 1941 there was very little operational flying. The dawn reconnaissances round the coast of Dorset, Devon and Cornwall continued and some early essays in air/sea rescue were accomplished. In June 1941 the squadron had the misfortune to lose both its C.O. and second-in-command in quick succession. W/C. Hancock was killed in a Proctor take-off accident and the next day S/L. D. Walker was flying to Roborough to make funeral arrangements when he was intercepted by four Me109s. Although the rear gunner shot down one of the enemy aircraft the Lysander was destroyed and both crew members killed.

In June 1942, when the squadron had been re-equipped with Mustangs, W/C. Hancock's successor, W/C. P. W. Stansfield, was seriously injured in an accident and W/C. J. R. Davensport, who had served in No. 16 Sqn. before the war, came to take over.

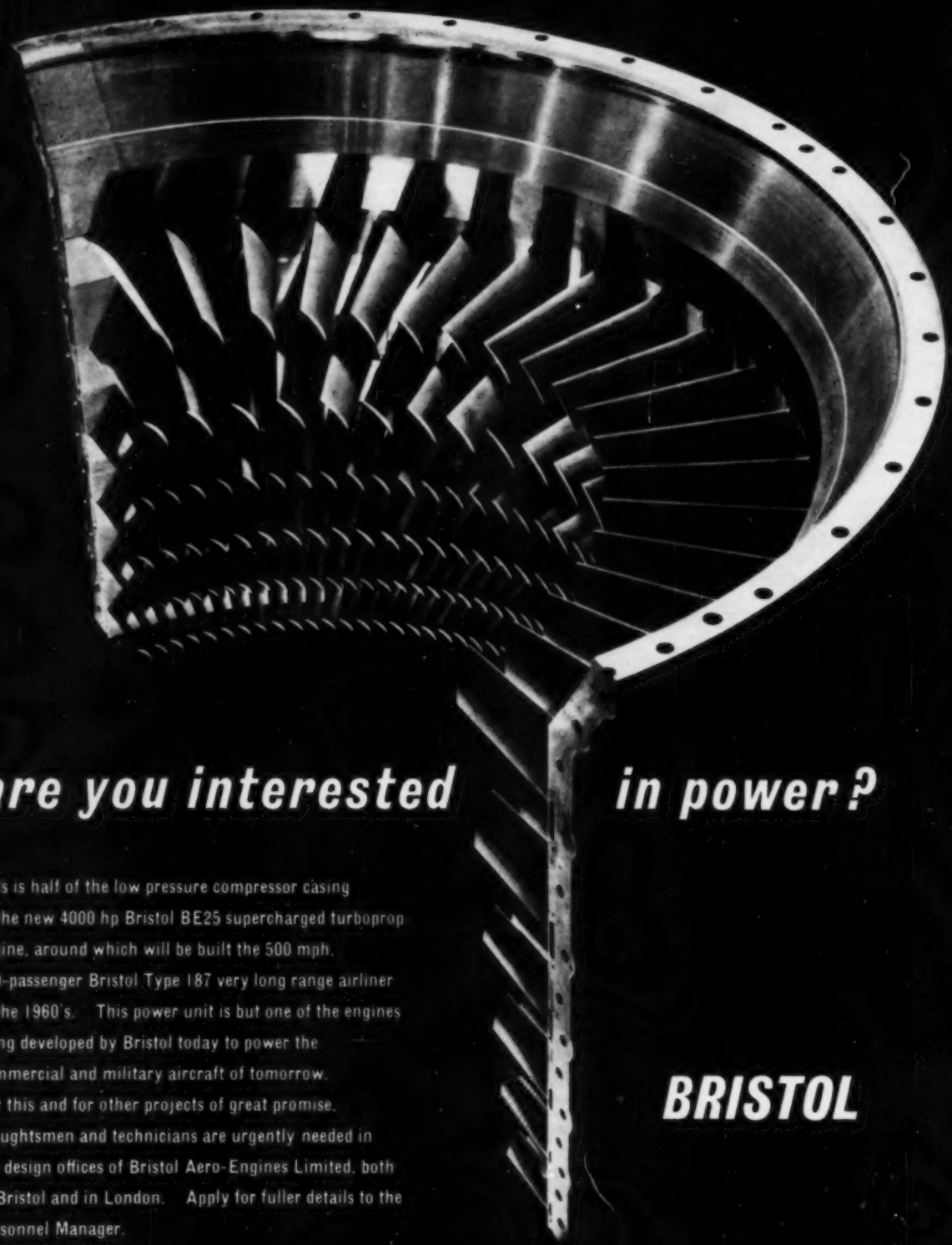
In November 1942, under the leadership of W/C. T. F. D. Morgan, D.F.C., productive operational flying began in earnest for the first time since the brief battle of France. Each flight in turn, detached to Exeter, was detailed for daily low-level shipping reconnaissance in the bay of St. Malo and along the Brittany coast. These missions were flown by pairs of aircraft with the alternative task of taking low-level oblique photographs of the enemy coastline, defences and shipping convoys. During the first month's operations three pilots failed to return. One of these was the second-in-command, S/L. K. Currie, who had just transferred from No. 208 Sqn. in Egypt.

On New Year's Day, 1943, the squadron moved to Andover and the task was increased to include the whole Cherbourg Peninsula and the bay of the Seine. Over Normandy and Brittany a start was also made on "Rhubarb" operations, i.e., low-level attacks on trains and other targets. Then, on June 1st, 1943, the old Army Co-operation Command was disbanded to make way for the formation of 2nd T.A.F., which was to be the principal air weapon supporting the Allied invasion of North-West Europe. The squadron moved again, this time to Hartford Bridge, and joined No. 34 Wing, which had been reformed as the Strategical Reconnaissance Wing of 2nd T.A.F. The move brought a change in both tactics and equipment. The new rôle was to be high-altitude tactical photography from single and unarmed Spitfire Mk 11s (replaced later by Mks 14 and 19). While waiting for its new aircraft, the squadron continued its "Rhubarb" operations and at the same time trained for the new tactics and techniques of high-altitude vertical photography.

The last operations carried out with Mustangs included some highly successful "Rhubarbs," during one of which F/L. R. E. Pughe bagged the record number of twelve trains. For this and other sorties he was awarded the D.F.C., as were F/Ls. A. M. Davis and D. A. Greville-Heygate. These were the first decorations won since the battle of France.

Among the squadron's most important tasks in the early part of 1944 was the survey of V.1 launching sites, but the tempo of air operations in preparation for the invasion was now speeding up, and from March 1944 the emphasis was switched to photography of damage caused by the numerous bombing attacks aimed at

Back in France: "B" Flight at Bertangles in 1940 with a Lysander.



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NO. 16 SQUADRON . . .

isolating the Normandy area from the rest of Europe. As part of this plan, No. 16 Sqn. moved with the Strategic Reconnaissance Wing to Northolt. Thus they were near S.A.G.E.F.H.Q., the principal user of all the photographic intelligence collected.

In September the wing followed the invasion forces to France, and there the urgent need for certain types of photographic reconnaissance necessitated a number of very difficult and dangerous low-level sorties over strongly defended targets. As a result the casualty rate increased, and during the six months between D-Day and the end of the year the casualty return represented about 75 per cent of the squadron's strength. Many very difficult tasks were brilliantly executed; the sorties of F/O. Gubb over Rotterdam were outstanding, as were the photographs of Venlo Bridge by F/O. Heath. The latter pilot was killed over the same target on his next sortie. After moving up to Brussels/Melsbroek, the squadron settled down to a winter of hard continuous flying until, after the Rhine had been crossed in March 1945, it moved up to Eindhoven for the final stages of the war.

The last few days of hostilities found No. 16 Sqn. back to its old task of shipping reconnaissance. Shortly after the war ended it returned to England and was disbanded at Dunsfold on October 19th. On the following day No. 487 Sqn., with Mosquito F.B.6s at Celle, was renumbered No. 16 Sqn. On March 31st, 1946, the Squadron was reduced to a number basis, but next day No. 56 Sqn., then based at Fassberg with Tempest 5s, became No. 16 Sqn. These aircraft were soon replaced by Tempest 2s and then by Tempest 6s, which remained in service until December 1948, when their place was taken by Vampire 5s, the unit's first jet equipment. The base was then at Gutersloh. It was on November 2nd, 1950, that the squadron moved to Celle, where it has since remained.

Present equipment is the Venom F.B.1, which the squadron received in February 1954. With these aircraft it has the dual rôle of high-altitude interception and ground attack. The continuation training programme is therefore based on this requirement.

From Celle the squadron can practise air-to-ground firing on the Fassberg range, while detachments to the armament practice camp at Sylt provide opportunities for air-to-air firing at towed banner targets. During its last detachment to Sylt No. 16 became the first squadron to shoot at banners at a height of 30,000ft.

The present Commanding Officer, S/L. G. G. G. Walkington, assumed command in December 1954. He has made a large number of changes in the domestic organization of the squadron with the aim of improving the conditions under which the ground-crews work and live. Now, after working hours, the airmen can retire to the rest room which has been provided in the barrack block, and equipped with easy chairs, a radiogram and a library. During working hours they no longer have to down tools and queue at the N.A.A.F.I. van; one of the rooms adjoining the hangar has been transformed into a rest room and tea bar, where they can take their tea break in comfort. Moreover, music is relayed throughout the hangar and workshops during working hours to relieve the monotony of some of the tasks the crews have to perform. Now being prepared is a drying room where the airmen can dry and iron their clothes to reduce their expenses.

On the sports field the squadron has not been without success. The airmen's soccer team acquitted themselves very well in the season just ended, reaching a high position in the inter-unit league. At the time of writing, the aircrew soccer team had reached the semi-final of the No. 83 Group Aircrew Soccer Competition for the second year in succession. Last year they were beaten 4-0 in the final by a Belgian aircrew team. In addition the squadron provides football, cricket and archery equipment for its members, and it is hoped to increase the number of available sports.

Vampires on the line at Celle. These aircraft have since been replaced by Venom F.B.1s with which the squadron is now equipped.

Personnel during an exercise at Florennes, Belgium, in June 1955. (Standing) F/Os. Payne, Smith, Lloyd, Russell, McCartney, Rowe, Bell, Leary, S/L. Walkington, F/L. Atherley, F/O. Ray, F/L. Lamb and F/O. Bunyan. (Kneeling) F/Os. Smillie, Baldock, Massie and Hall.

Not only on the sports field has the squadron achieved success. F/O. B. F. Baldock, one of the pilot-attack instructors, won the Leconfield Trophy for the best all-round armament performance in a recent course at the Central Gunnery School. During the last detachment at Sylt the squadron established a record in the operational turn-round exercise. Eight aircraft flew two sorties each, with full ammunition, and fired 9,455 rounds for one stoppage, a performance which reflects very well on the armourers, who often work in difficult and unpleasant conditions.

Of the personnel at present serving, several are considered by the squadron to be particularly worthy of mention. Sgt. O. Roberts, N.C.O. i/c discipline, who is now in his third tour with No. 16, was with it in the battle of France. Sgt. D. Johnston has been with the squadron for 4½ years; and Sgt. Sowerby, armament N.C.O., has, together with his armourers, provided much of the effort which has contributed to the armament success. F/Sgt. W. Scott, N.C.O. i/c ground-crew, has been with the squadron for only a year, but is described as "a very valuable member."

In July 1954 No. 16 Sqn. Association was reformed, under the chairmanship of S/L. R. U. P. de Burgh, with the aim of strengthening the links between past and present members. The association's president is Air Marshal H. P. Fraser, C.B., C.B.E., A.F.C., and the vice-secretary is F/L. G. O. Eades, of the Royal Air Force College, Cranwell.

ACOUSTICS COURSE DINNER

SOME 95 engineers and scientists attended the one-week course, *Acoustics for Aeronautical Engineers*, held at the University of Southampton from April 15th to 21st. Proposing the health of the University at a dinner in Glen Eyre Hall on April 19th, Mr. H. B. Irving (Ministry of Supply) said it was hoped that variants of this first course, which had covered a wide field, would be held in the future: these might be of a more specialized nature. Professor Richards and his team at Southampton, he pointed out, had become a "big noise" in the field of acoustics—whether measured in the near field or the far field.

Replying to the toast, the Deputy Vice-Chancellor of the University, Prof. E. T. Davies, referred to the international flavour of the acoustics course; overseas students had come from Sweden, Germany, and Australia. He went on to discuss industry support for university work, emphasizing the value which would arise from the release of senior industry men for short periods at the universities.

The unusual double toast of "The Industry and the Ministry of Supply" was proposed by Sir Henry Tizard, Pro-Chancellor of the University. If the aircraft industry were really healthy, he affirmed, we would not have the M.o.S. The industry appeared to be still a baby wanting to be artificially fed—it had, of course, been artificially fed for the last 50 years. For the Ministry, however, we had high praise, although, the speaker hinted, still more praise would accompany more support for the University. The Ministry was doing a good job, and he wished it good health—but only as long as was really necessary. The sooner it disappeared, the better.

Sir Cyril Musgrave, Second Permanent Secretary to the Ministry of Supply (deputizing for the Parliamentary Secretary, Mr. F. J. Erroll, M.P.) replied, re-affirming the importance attached to the research on noise being carried out at Southampton under M.o.S. contract. The Ministry regarded aircraft silencing equipment as an essential standard tool, he said; unless aircraft noise was reduced, aircraft development would be drastically slowed down.

Logistic Transport

Further Particulars of the Mighty Douglas C-133A

TREMENDOUS capabilities of the forthcoming Douglas C-133A transport were recently disclosed in the *MATS Flyer*, the official publication of the Military Air Transport Service. The article is reprinted here in full, with slight alterations to remove certain words which are purely American. Readers are also referred to our first appraisal of this aircraft in our issue dated February 17th, 1956.

Early this spring the C-133A, MATS' first production turboprop aircraft, is to make its initial flight. By the end of next year MATS should have 12 of them in service.

The all-cargo turboprop transport will be able to fly non-stop from Los Angeles to New York with the ton-knot equivalent of 22 loaded freight cars. Two C-133As will be able to haul as much cargo in the same interval of time as one liberty ship or five C-124 Globemasters.

The transport is propelled by powerful turboprop engines: four 5,700 e.h.p. Pratt and Whitney T34s as in the experimental YC-124B. However, 7,500 e.h.p. Allison T54s (coupled T56s) are also under consideration. The turbines plus the large pressurized fuselage add up to high speed, long range and cavernous capacity, a promising combination for both strategic and tactical operations.

MATS will supervise C-133A Phase VII testing, checking the aircraft for operational suitability. The C-133A MATS will test is scheduled for December 1956 delivery and will be the eighth off the production line. The first seven will be tested by the manufacturer and at Edwards Air Force Base, California. MATS has been priming for the C-133A's advent by piling up experience with turboprop-fitted transports. A pair each of Boeing YC-97Js, and Convair YC-131Cs has been service tested by the 1,700th Test Squadron, the Stratofreighters being test beds for T34s and the Convairs for Allison YT56s.

Douglas' assignment has been to construct a turboprop transport that will haul a 50,000-pound payload 3,500 nautical miles, about the optimum for the foreseeable future. Such a plane will eliminate the need for intermediate landings, and, consequently, the maintenance and service delays that go with before-destination stops. Since four out of five aircraft accidents occur during take-off, climb, descent and landing, the C-133A will reduce exposure to accidents.

The story of how Douglas came to be tabbed to manufacture a turboprop transport starts shortly after the C-124A became operational. The Air Force, out to increase still further the military transport efficiency of the aircraft, contracted in July 1950 for a turboprop version, the YC-124B. Originally, the intent was to pressurize only the flight deck. Then, in September 1951, the Air Force elected to have the main cabin pressurized as well. It was to become evident, though, that weight penalties incurred in pressurizing the C-124 fuselage would be excessive. Additional studies were made using a fuselage of circular cross-section for pressurization and using, with minimum modification, the YC-124B wing, nacelles and tail surfaces. Designated Douglas Model 1324, the preliminary design was submitted in October 1952, and, upon receipt of U.S.A.F. approval, detail design began.

Shortly thereafter, requirements for a high-wing, low-floor aircraft were established, which resulted in the submittal of another preliminary design designated Douglas Model 1333. The Air Force approved the design, which superseded Model 1324, and detail engineering on Model 1333 (the C-133A) was started in February 1953. A full-scale mockup was built and the design was finalized by the Mockup Review Board held in December 1953.

The C-133A features a pressurized cabin with a 10,000-foot cabin altitude maintainable at an altitude of 35,000 feet. The pressurized area of the aircraft extends from the nose to a pressure bulkhead slightly aft of the main cargo-loading doors. The fuselage of the C-133A is of a semi-monocoque type, wherein frames and stringers assist the skin in standing stress.

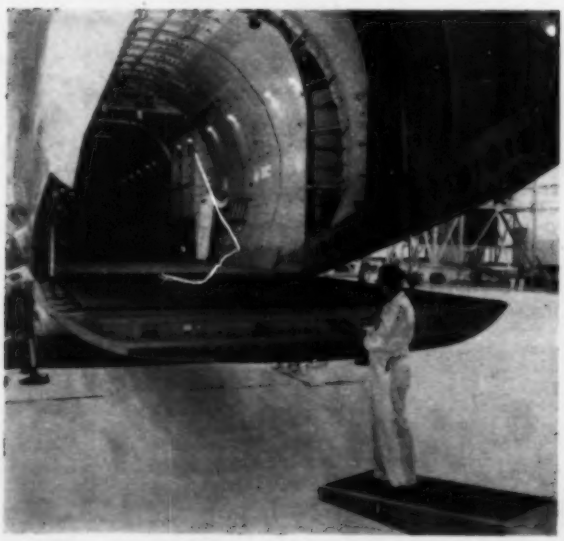
Basically a freighter, with a design gross weight for all flight conditions of 255,000 lb, the C-133A has a floor pattern that will permit the installation of 200 seats; Douglas is submitting a proposal for Air-Evacuation configuration.

Performance data is secret. Suffice to say that cruise speeds for C-133A long-range operation exceed the maximum level-flight speed of most World War 2-type fighters. The C-133A will have the capability of transporting 50 short tons of cargo more than

Points worth noting in this view looking aft are the hydraulically operated door (extreme right), the elegant arrangement of the cables and piping, the profusion of cargo shackles on the strong floor and the bright and clean finish (most unusual for a prototype).

The photograph opposite shows the first C-133A standing on the five-pointed star in the conference room at Long Beach. When the photograph was taken the subject was "Finalization Handbook No. 6" and the engineer's desks and files of drawings can be seen in the foreground. The vertical black lines are cables hanging from roof beams.

(Below) Vehicles will enter up this powered ramp which, with a corresponding rear panel, is sealed to support the full cabin pressure. The level loading floor is only 4ft 2in from the ground.



1,000 miles. The fuselage is big enough to load such sizeable units as large aircraft outer-wing panels, dolly-mounted aircraft power packs, radar trailers and bulky airfield construction equipment.

The aircraft has two loading entrances. The rear loading door will permit loading of a 12-foot high item on to the 142-inch-wide floor. Another opening located on the left side of the aircraft near the front of the main cabin is 100 inches high by 106 inches wide, and will permit loading directly from a truck or trailer. The two openings make possible simultaneous front-and-rear loading of the transport. Use of fork trucks inside the aircraft will speed loading and unloading. A conveyor system, installed on the floor, is being studied for handling palletized cargo.

A ramp is built into the rear loading door and operates hydraulically. It can support 25,000 lb in a horizontal position and will raise from the ground with a 10,000-lb load. It can be positioned to varying truck or trailer-bed heights from the aircraft floor height of 50 inches. Use of two removable three-foot-wide toe sections will give a continuous ramp surface from ground to aircraft. The sections adjust laterally to vehicle wheel tread widths of up to 10 feet.

The design useful load for the C-133A is 145,583 lb; empty weight of the aircraft is 109,417 lb. Its main cargo floor is stressed to support concentrated loads as well as evenly-distributed ones.

Tail area of the C-133A departs from the C-124 pattern. The C-133A has larger vertical and horizontal tail area than the Globemaster and the horizontal tail is positioned lower than on the C-124, being back to where it was on the C-74, forerunner of the C-124. The horizontal-tail height has been figured to give the C-133A good stall characteristics and to provide stall warning in the form of buffeting as the horizontal tail becomes immersed in the wing wake. A flaps-down stall approach will produce tail buffeting about eight knots before the stall. With flaps up, buffeting will occur about 15 knots before the stall. The new transport at its maximum gross weight of 255,000 lb will stall with clean configuration at 136 knots and with full flaps down at 101 knots.

The larger vertical tail area gives the C-133A a higher degree of directional stability than the C-124 and the greater horizontal-tail area also helps the new transport to resist changes in pitch attitude. Size of the C-133A horizontal tail has been figured for longitudinal stability with lateral stability provided by the dihedral effect of the wings and the vertical tail surface. The high wing and high nacelles give the new freighter better longitudinal stability than the Globemaster. Rudder and elevator operation of the two aircraft are similar.

The wing is a full cantilever stressed-skin type consisting of a

This view is taken from the C-133 loading ramp, which, in flight, transmits airframe loads as well as withstanding cabin pressure.

LOGISTIC TRANSPORT . . .

centre section and two removable outer panels. The ailerons, located on the outboard wing panels, provide good lateral control. Good take-off and landing characteristics result from the high-lift Douglas-type double-slotted wing flaps.

Fuel capacity of the C-133A is 16,500 U.S. gallons. Oil capacity is 60 gallons. The aircraft can refuel at 600 gallons a minute, which means that it would take about 27 minutes to refuel the C-133A. It has a single-point pressure-refuelling system, with the nozzle adaptor located in the forward portion of the right-hand landing-gear pod. Most of the fuel lines are buried within the tanks. In the event of line break or leakage, fuel will merely drop into the tanks and no hazard will exist.

The four turboprop engines will be supplied with fuel boost-pump pressure, and two gas turbine auxiliary power units will be fed by gravity. These gas turbine units are located in the left landing gear pod aft of the wheel well. They supply compressor-bleed air for the ventilating and pressurization requirements, for preheating main engine oil systems and for starting engines. Each unit also drives an hydraulic pump and one unit is equipped with an alternator which serves as an auxiliary source of A.C. power. The fairing pods also house the main landing gear. The fully-retractable main landing gear consists of two twin-wheel units in tandem on each side of the aircraft.

Each twin-wheel unit is an independent system with its own shock-absorber strut, vertical bracing and retracting linkage. The landing-gear control does not provide for selective operation of the forward and rear units but is such that malfunctioning of one unit does not compromise the operation of the other. The co-rotating nosewheels are steerable through an arc of ±150 deg using hydraulic pressure from the landing-gear down-line.

A new feature of the C-133A is a pair of small wheels with a single shock strut mounted as a retractable tailwheel unit. Even when retracted, the wheels protrude slightly below the aircraft, partially serving their purpose if a landing is made in excess of a 7½ deg tail-down attitude. In the event of hydraulic failure, the main gear and nose gear may be mechanically unlatched and will free-fall into the down and locked position. A pneumatic emergency brake system is provided, with variable pressure and differential application available through the normal brake pedals.

The C-133A is fitted with 18-foot-diameter, three-bladed, reversible Curtiss airscrews. Pitch-changing force comes directly from the driving shaft and not a separate electrical or hydraulic unit. A single lever effects pitch change, simultaneously co-ordinating airscrew pitch and fuel metering. The average reciprocating engine may be operated normally through a range of about 50 per cent of its r.p.m. limits but the turboprop must be operated within the upper ten per cent of its limits and, for maximum efficiency, within one per cent. So, because the turboprop demands precision co-ordination between airscrew pitch and fuel metering, there is a single lever.

The C-133A will have a negative torque control to suppress windmilling drag from an inoperative engine. In such a situation there is not only a lack of thrust from the failed engine but additional effective thrust is lost in driving (windmilling) the failed engine. Whenever a condition of negative torque (airscrew driving the turbine) exists, the N.T.C. system will cause the airscrew to start toward the feathered position. It will not completely feather the airscrew but will move the blades into a high (coarse) pitch angle and reduce the r.p.m. of the windmilling engine, thereby reducing the drag to the maximum extent possible short of complete feathering.

The flight deck is in the forward upper portion of the fuselage where stations for pilot, co-pilot, navigator and systems engineer are located. Sleeping accommodation for three relief crew members are at the aft end of the flight deck, with the forward bunk alterable into an aft-facing seat.

The C-133A is conventional in its complement and positioning of operational instruments. The installation of turboprop engines eliminates certain powerplant instruments, such as cylinder-head temperature gauges, but replaces them with new items, such as exhaust-temperature gauges.

The basic arrangement consists of three panels:

1. A forward or pilot's panel, on which two functionally-duplicate sets of flight instruments are located, is situated directly forward of the two pilot stations with a centre area between, on which the instruments for all four engines are displayed.
2. A navigator's panel on which all normal instrumentation for this operational function is located.
3. A systems engineer's panel for indicational instruments of the various aircraft systems (fuel, electrical, air-conditioning, ice-protection and hydraulic systems).

The two latter panels are arranged behind the pilot's station so as to be directly in the normal-vision plane of the pertinent crew member. The oxygen installation of the C-133A consists of two separate low-pressure gaseous systems. One is for the pilot, navigator and forward bunk stations, the other for the co-pilot, systems engineer and rear-bunk stations.

The aircraft has an ice-protection system designed to combat ice formation by maintaining the surface temperatures of the protected areas at such a level that ice never forms (anti-icing) or by permitting the ice to build up and then removing it by cyclic action of either thermal or pneumatic equipment (de-icing). The wings are protected from ice by a heated air, double-skin, cyclic de-icing system which allows ice to form and then loosens it by melting at the airfoil surface. Pneumatic de-icing boots are fitted to the leading edges of the empennage. The rubber boots inflate mechanically to loosen ice that has been allowed to accumulate. The airscrews are cyclically de-iced by means of external heating elements cemented to the leading edges of the blades and blade cuff assemblies, and by a combination of cemented blankets and Calrod units on the inner surface of the spinner components.

Four life rafts, equipped for automatic ejection and inflation, are located in the centre wing section. Two are installed on the right side and two on the left, and all are accessible from the emergency escape hatches. A separate raft installation, located just aft of the flight deck, is provided for the flight crew. A single cable control-system for each raft is installed with a tee handle located immediately adjacent to the escape hatch.

"Because all the combat forces will eventually be all jet," Lt.-Gen. Joseph Smith (MATS' commanding general) has stated, "it is inevitable therefore that the transports will be powered with turbines in order to be harmonious and compatible with the tactical units which we will support in peace and war." With the appearance of the C-133A on the scene, the MATS commander's forecast is on its way to becoming a reality.

HAWKER SIDDELEY MODELS

TUNNEL models for projected supersonic aircraft and missiles are extremely difficult to manufacture. Their subtle profiles have to be correct to tenths-of-thousandths of an inch, and in many cases they can be constructed only in high-tensile steel.

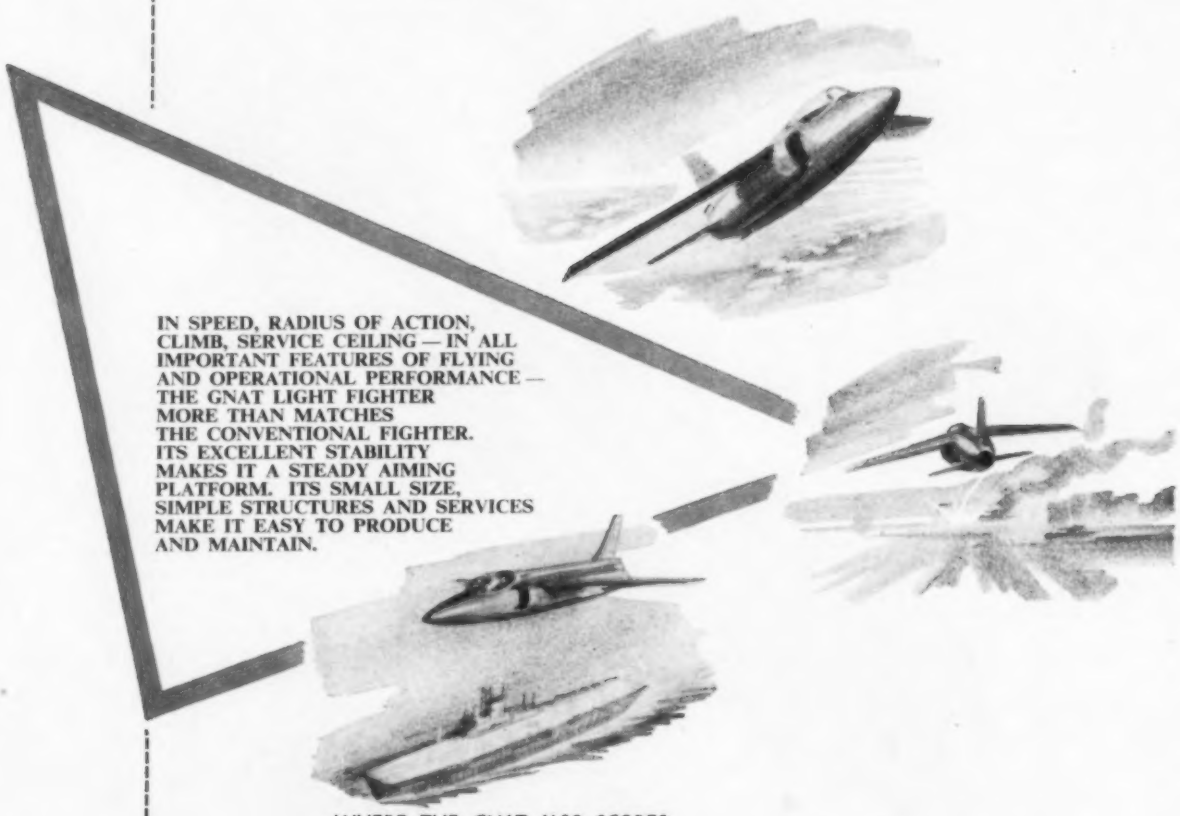
Since they began the bulk-production of such models less than a year ago the Hawker Siddeley Group have established themselves as leaders in this field. A member of the Group—Armstrong Whitworth, at Baginton, near Coventry—has invested over £100,000 in machine tools alone for this work, on a private-enterprise basis. Today they are making models not only for the Group but for the Ministry of Supply and (remarkably enough) other firms in the industry. Some of the A.W.-built models have cost as much as £8,000, and their manufacture involves keeping the air in the toolrooms free from dust and at uniform temperature. In addition, exceptional security systems have to be enforced.

(6) MERITS OF THE GNAT

Versatility

The Gnat jet fighter fills three separate and distinct roles — interceptor, tactical and naval. As an interceptor it carries two 30-mm. cannon, identification equipment, radar gun ranging, navigational and homing aid and V.H.F. (or U.H.F.) radio and standby set. In its tactical role, operating from reinforced grass runways, it carries two 30-mm. cannon and two 60-gal. drop tanks plus 2 × 500-lb. bombs, or 12 × 3-in. rockets or two Napalm bombs. Alternatively, it can carry two 30-mm. cannon and 18 × 3-in. rockets, or two 30-mm. cannon and 6 × 3-in rockets and 2 × 500-lb. bombs.

As a carrier-borne fighter it has two 30-mm. cannon, standard naval instruments and equipment, one hour's internal fuel, or two hours' fuel with external tanks; it requires no wing folding and therefore escapes the weight and performance penalties imposed upon conventional naval fighters, and takes up little stowage space.



IN SPEED, RADIUS OF ACTION, CLIMB, SERVICE CEILING — IN ALL IMPORTANT FEATURES OF FLYING AND OPERATIONAL PERFORMANCE — THE GNAT LIGHT FIGHTER MORE THAN MATCHES THE CONVENTIONAL FIGHTER. ITS EXCELLENT STABILITY MAKES IT A STEADY AIMING PLATFORM. ITS SMALL SIZE, SIMPLE STRUCTURES AND SERVICES MAKE IT EASY TO PRODUCE AND MAINTAIN.

WHERE THE GNAT ALSO SCORES

Judged by conventional fighter standards, the Gnat

(1) has a higher service ceiling, higher rate of climb and better manoeuvrability;

(2) combines hard-hitting armament with exceptional stability at all speeds;

(3) can be transported more easily, and is less exacting in its airfield requirements;

(4) is easier to produce;

(5) is easier to maintain;

(6) costs far less to buy and operate.

FOLLAND *Designed and Built by the Pioneers of the Light Jet Fighter*

FOLLAND AIRCRAFT LIMITED · HAMBLE · SOUTHAMPTON · HANTS

Wing Fold and Locking Pin Jacks

A variety of hydraulic jacks is required for modern aircraft, the construction of each jack being "tailored" to fit its particular function. The jacks illustrated are but two of over 40 different types of British Messier 4,000 p.s.i. hydraulic units fitted to the Short Seamew.

Locking Pin Jack

Wing Fold

BRITISH MESSIER

GLOUCESTER · ENGLAND

PUB/BM/3/56

LYCOMING T53

America's First Free-Turbine Aero Engine to go into Production

ALTHOUGH they are rarely in the news, the Lycoming company have made many thousands of high-quality aero engines since their first was designed in 1928. The majority of these units have been relatively small air-cooled piston engines of the flat-four or flat-six layout and they have found employment in many different kinds of fixed-wing aircraft and helicopters. In 1936 the company became a division of the Avco Manufacturing Corporation and their headquarters are now in Stratford, Connecticut. During the Korean crisis they were brought in as a second source of Wright radial engines, of which they have made many hundreds for large military helicopters and various fixed-wing types.

Within the past three years Lycoming have entered the gas-turbine business; and, in passing, this seems to be the only instance of a small-piston-engine firm starting production with its own designs of small turbines.

The work is under the general direction of the vice-president (turbine engineering), Dr. Anselm Franz, one of the pioneers of the gas turbine during the 1930s and World War 2, when he was largely responsible for the design of the Junkers Jumo 004, one of the most important turbojets of the erstwhile Luftwaffe. He has gathered together a team of widely experienced engineers, who have been developing two new turbine powerplants against a U.S. Air Force (now U.S.A.F./Army) contract received in 1954.

The larger of the two engines is the Lycoming T55, of 1,650 horsepower, which is being prepared for both the Air Force and the Army. The smaller engine is the T53, depicted here, which is also now being developed against a joint Air Force/Army contract.

Intended for application in all types of slow-speed aircraft, both fixed-wing and rotary-wing, the T53 is the first free-turbine engine in America to reach beyond the paper stage. This feature has enabled a design to be achieved in which torque varies as a reciprocal of output-shaft speed so that power can be held constant at varying r.p.m., and *vice versa*. The whole design incorporates many ingenious mechanical features which should make it an eminently reliable long-life unit, easy to instal and to maintain.

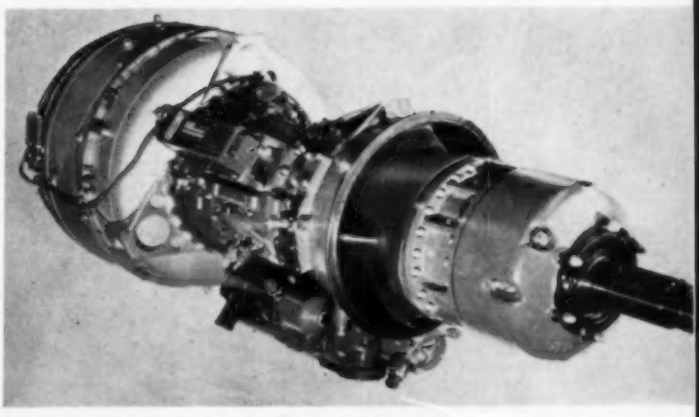
An annular intake leads to a compressor with five axial stages and a single centrifugal stage which throws the air out to the diameter required by the external annular combustion chamber. The latter has a high efficiency and allows the engine to be very short without exceeding the diametral space envelope required by the accessory grouping. The chamber can be removed as a single assembly, together with the single-stage power turbine and single-stage compressor turbine. Access to the compressor is gained by unbolting the top half of the casing. Accessories are bolted to drive faces around the lower part of the compressor casing, the engine itself being supported by a pad on each side of the intake casting and three mounts spaced at 120 deg around the centrifugal-compressor diffuser case.

Two basic versions of the engine are to be made available. The helicopter version, designated LTC1B-1, has a nominal output-shaft speed of 6,000 r.p.m., the reduction gear (of 3.22:1 ratio) being housed in the centre of the intake casting. For fixed-wing applications the Model LTC1D-1 is being developed with an additional adaptor gearbox mounted on the front of the existing reduction gear. At present this increases the weight significantly (see data below) but a weight reduction of approximately 50 lb, to a total of 499 lb, should be possible when the engine gets into production. Provision has also been made for the extraction of power from the rear, or "hot," end and, if required, shaft power can be extracted from both ends simultaneously at different output speeds.

Over a dozen prototypes have been built and flight development

LYCOMING XT53-L-1 DATA

	Model LTC1B-1	Model LTC1D-1
Shaft horsepower (military rating) ...	825 s.h.p.	808 s.h.p.
Shaft horsepower (maximum continuous)	770 s.h.p.	755 s.h.p.
Jet thrust (military rating)	102 lb	102 lb
Specific fuel consumption (military rating)	0.71 lb/s.h.p./hr	0.72 lb/s.h.p./hr
Dry weight	460 lb	549 lb
Nominal diameter	23 in	23 in
Length	47.8in	64.5in
Nominal output shaft speed	6,000 r.p.m.	1,575 r.p.m.
Turbine to output shaft gear ratio ...	3.22 : 1	12.25 : 1

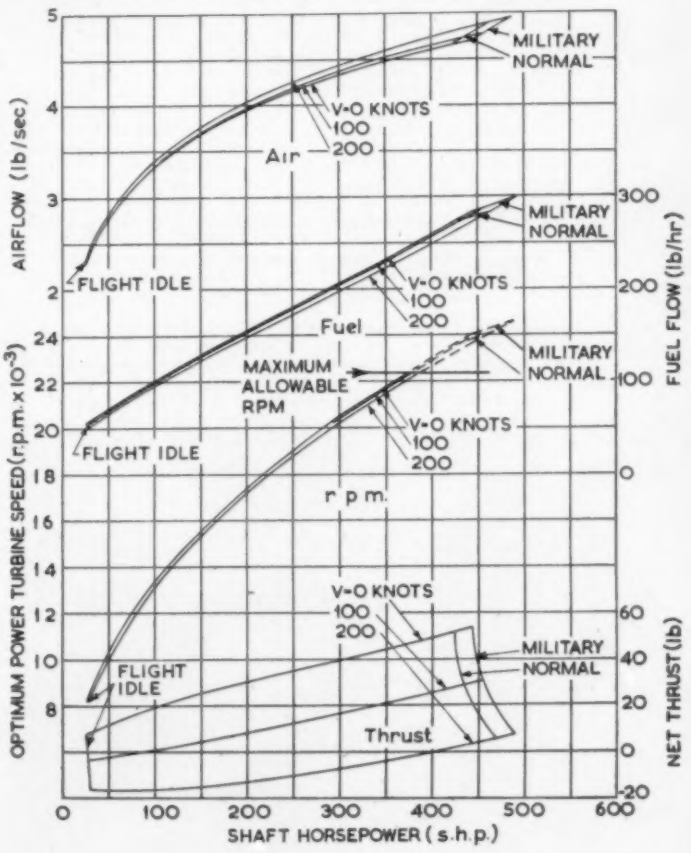


In this form the Lycoming T53 has an overall reduction gear ratio of 12.25:1, the supplementary box and airscrew shaft being visible in the foreground. Helicopter engines will be shorter and even more compact.

has been assigned by the U.S.A.F. to a Kaman HOK helicopter for which the conversion is now largely complete. The first production application is likely to be in the Army's Bell XH-40 utility helicopter, but the T53 may also be seen in later developments of the HOK and the Doman H-31. The engine has also been named as a possible power unit for the Frye F-1 Safari fixed-wing utility transport. Automotive orders are expected and the U.S. Navy has ordered a large number for marine use. A commercial-aircraft version, derated to 690 h.p., may be certificated in the Bell 204 seven-seat utility helicopter. The basic T53 engine has already passed its 50-hour qualification tests.

In America it should have a fairly clear run, although it may be up against the General Electric T58 at the upper end of its power category. In Britain the only comparable engine is the Napier Gazelle which, like the T58, will be rated at a considerably higher power. In fact, Gazelle development should eventually give almost twice the power of the T53.

Estimated performance for the LTC1B-1 helicopter engine at 25,000ft using a large (i.e., low-thrust) jet nozzle. Duct losses are ignored.



CORRESPONDENCE

The Editor of "Flight" does not hold himself responsible for the views expressed by correspondents in these columns; the names and addresses of the writers, not necessarily for publication, must in all cases accompany letters.

Aircraft Nomenclature

ALTHOUGH, when compared with other aspects of aviation, the naming of aircraft is a matter of minor importance, one cannot help being struck by the present practice of duplication by some firms.

Surely the sole object of giving a name to anything is that it may then be identified and referred to without any doubt whatsoever? Why, then, nullify the purpose of nomenclature by employing the same name again, especially within a few years? One cannot believe that there is any shortage of words, apt or otherwise, so what is the reason?

The position is not so bad when the same name is given to machines made by different companies. When, however, one company—such as Westland—proceeds to repeat its past names, as in the case of the Whirlwind (after far too short a period), the Widgeon (the original parasol still flying) and now the Wessex, the only result is confusion. Westminster was chosen, so why was it not possible to find alternatives to the last three?

Other examples that come to mind at once are two Furies by Hawkers, two Comets by de Havilland, Hornet by both de Havilland and Hawker, in addition to possible confusion between D.H.'s Hornet and the Hornet Moth, owing to abbreviation of the latter. D.H.'s choice of Venom is passible in view of the obscurity of the 1936 Vickers fighter.

Numerous other aircraft constructors seem to find, without difficulty, appropriate names for their products, without having to resort to using the same ones again.

There must be many enthusiasts among the staffs of our companies who would welcome the opportunity of suggesting names for new machines and it would be gratifying to see a little more imagination used in this respect.

South Benfleet, Essex. P. M. H. LEWIS.

The de Havilland D.H.9

IN common with all Mr. J. M. Bruce's articles, that on the D.H.9 was most interesting. There are, however, one or two points upon which I would like to comment.

The 9 is compared rather too unfavourably with the 4, I think. With about 200 hours' flying of the former and 180 hours' experience with the latter, I know that I much preferred the 9 in many a tight corner. During 51 sorties with the 9, the percentage marred by engine trouble was not unduly high for those days. I consider my squadrons (Nos. 49 and 103) did excellent work with them. No. 49 did even better than Mr. Bruce suggests.

On June 7th, 1918, five of us were attacked by 40 Huns, with the result that five of theirs were disposed of, one of ours was lost and my machine was shot down. We got down on our wheels, but C6114, of which I had been virtually "sole owner," was not worth keeping. Interesting, in that the Hun evidently thought more of the 9 than present-day historians do, for when C6114 was a "sitting duck" at 2,000ft with a "dead stick" (no, it was shrapnel, not Puma design!), the Huns turned for home! (Aside: Little did they know that my observer's gun had gone too!).

I am interested to learn, at this late date, that the 9 had "an internal bomb-bay which could . . ." Blowed if I ever found it!

In this May 1918 photograph Mr. A. H. Curtis is seen in the pilot's cockpit of C6114, a D.H.9 of No. 49 Sqn. at Beauvais. He remarks that the squadron's "white dumbell" insignia, sometimes painted on the earlier D.H.4s, seldom appeared on the 9s.

Anyway, thank goodness we did not have 9s with Sunbeam Arab engines. If "as a failure, it was probably surpassed in magnitude only by the A.B.C. Dragonfly," what *must* the latter have been like?

I tested a number of Bristol Fighters, shamefully fitted with Arab engines, and they rarely failed to provide some trouble. Indeed, with the prospect of a court-martial, I refused a request from a member of the W.R.A.F. to take her up, until a Rolls Bristol came into my hands. This was just as well, because the C.O.'s car arrived at the hangar during the flight and we had to stooge around for half an hour until it departed; at such a *moment critique*, no Arab would have co-operated!

May there be many more such articles from Mr. Bruce's pen.

Potter's Bar, Middlesex. A. H. CURTIS.

I HAVE been intending to write a word of congratulation on your series of historic aircraft, etc., for a long time, but it was the three pages of "Collector's Items" in a recent issue—quickly followed by J. M. Bruce's article on the D.H.9—that eventually acted as the starter's pistol. Certainly some of these photographs were gems, and I hope that similar batches may follow from time to time.

Regarding the unusually camouflaged D.H.4 (R.N.A.S.) on page 331, could this be one of the aircraft that were painted in a blue and biscuit scheme mentioned by C. Snowden-Gamble in *Story of a North Sea Air Station*?—although the density of the shades hardly suggests this. The "dark" shade approximates very closely to that of the red in the rudder stripes—could it indeed be this colour, some dope having been left over after completing the "dazzle" scheme on a flying-boat? Or mayhap it was a try-out for a boat scheme? This may not be such a wild suggestion as it seems, as the camouflage on the D.H.4 seems to follow the pattern adopted on the R.N.A.S. boats, insofar as only the fuselage and fin have been "decorated" and the upper surfaces of the wings left plain. The propeller appears to have been included in the colours of the fuselage. It certainly would be interesting to know what the colours of this aeroplane were exactly.

Luton, Beds. P. L. GRAY.

British v. American Airliners

THE hitherto rosy outlook for sales of British long-haul aircraft has become rather anaemic after the events of the last six months. Mr. Peter Masefield recently described the recent spate of orders for jets as "keeping up with the Joneses." Unfortunately for this country, and in particular for Mr. Masefield's own company, the Joneses and their emulators are doing their shopping on the West Coast of America. The opportunity to break the monopoly of the Americans in this field is, or rather was, during the transition period from piston engines to turbines. Although the Britannia first flew in 1952 it has yet to carry a paying passenger. No British aircraft will sell abroad until it has proved itself or established a pedigree—like Douglas, for instance. The result of this delay is the acceptance of another generation of piston-engined long-haulers (the DC-7C and Super Constellation) and the announcement of their successors, the Boeing 707 and the DC-8. Nearly every major airline with the exception of B.O.A.C. has committed itself to combinations of two or more of these American aircraft. The question therefore arises: who will buy the Britannia? Fine aircraft that it promises to be, it looks like making its debut in July about one year too late. I sincerely hope that I am wrong.

However, "more jam tomorrow." A successor to the Britannia has already been announced. This, incidentally, would require government financial support—support that was denied to the V.1000/VC-7 a few months ago. The latter could be available at least four years earlier and would be a much better prospect, if only because of its speed. After all, speed is the essence of first-class air travel.

Our other entrant in the "big league"—the Comet— must and will re-establish itself. The consequences of the disasters of 1954 are becoming more and more apparent as our lead has been lost, if order-books be the sole criterion. However, it is most disappointing that de Havilland are not thinking in terms of non-stop Atlantic operation for Comet developments. This is especially so since the still-birth of the VC-7.

The prospects in the medium-range field are much better, thanks to the efforts of Vickers-Armstrongs, Rolls-Royce and B.E.A. They have done the trick with the Viscount and should

HAVING A FLUTTER

This is an electronic analogue computer, designed and built by ENGLISH ELECTRIC for work at their Aircraft Division's Research establishment at Warton on problems of aircraft flutter and stability. A mathematician with a desk calculator would find it fairly easy to solve problems of flutter in two degrees of freedom, very difficult to solve problems in three degrees of freedom, and impossible to go further. This machine solves, in a few minutes, problems of flutter in six degrees of freedom. This does not mean that the mathematician becomes redundant. To produce the figures for a family of problems for the computer to work on may easily take him a fortnight. The computer then does in an hour or so what would take the mathematician 6 months to do—supposing he could do it at all.

On problems of stability the computer can do a theoretical analysis, which it can then translate into practical terms with the aid of a mock-up cockpit, complete with flying controls, simulated instruments and a cathode-ray artificial horizon. In this way a pilot can study the effects of different control and stability characteristics without ever leaving the ground and can get a fair approximation of the feel of a projected aeroplane before it has been built.

Thus, with ever more elaborate equipment, are ENGLISH ELECTRIC designing today the aeroplanes of tomorrow. For when aircraft are required to fly at stratospheric heights and supersonic speeds, hopes and hunches must give way to science and certainty.

Design starts from an attitude of mind

Partners in Progress with Marconi and Napier in THE ENGLISH ELECTRIC GROUP

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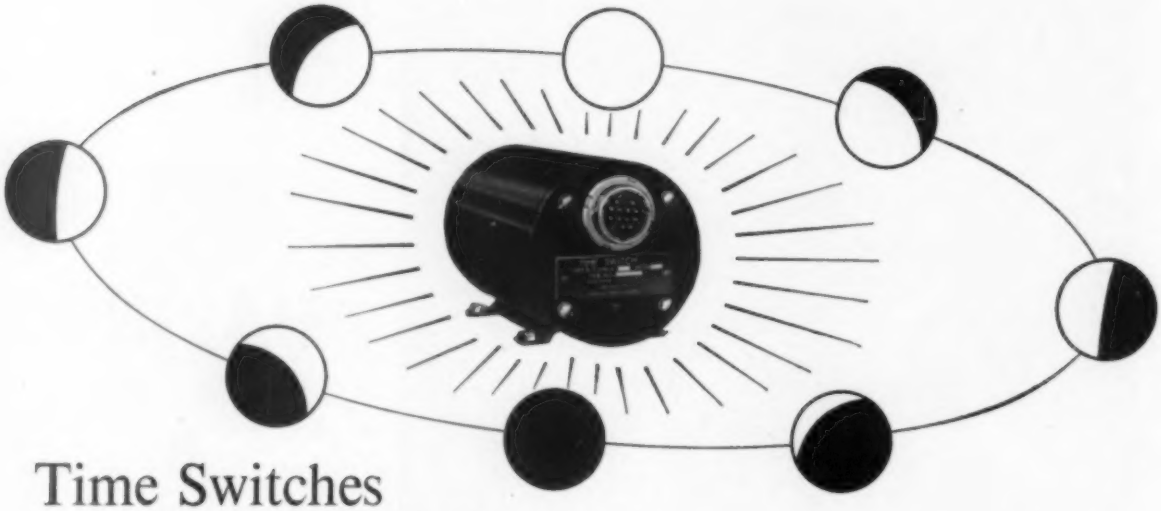

Time Switches *by* TEDDINGTON

Teddington precision time switches are powered by a 24V (nominal) D.C. motor which is governed to provide a constant speed over the wide variations of voltage and temperature encountered in aircraft. They provide multi-circuit sequencing with operating cycles ranging from 1½ seconds to one hour, and, where necessary, are fully suppressed against radio interference.
Satisfying all aircraft requirements for timed sequencing, these compact and lightweight switches have a minimum overhaul life of 1,000 hours. In the switch illustrated the sealed case can withstand an internal pressure of 20 p.s.i..

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The Bristol Britannia is equipped with a warning device that vibrates the control column indicating the impending stall. This Control Column Vibrator was designed and developed by Western Manufacturing and is now in full-scale production at our Woodley factory.

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CORRESPONDENCE . . .

do the same with the Vanguard if it appears on time. If not, the Electra will sweep the board. The fact that K.L.M. have ordered Electras should not be unduly discouraging, as that airline seems compelled to order any civil airliner that emerges from California. However, it is a great pity that the Viscount is not by now being built under licence in America. If this were so, sales of the Electra would be appreciably reduced and the Convair 440 might not have appeared at all. Most American airlines "buy American" at all costs rather than the imported product, although the latter might be technically superior. This was admitted by Eastern Air Lines when they decided on the powerplant for their Electras. Fokkers have realized this and are having the Friendship built in the U.S.A. by Fairchild. This will reconcile the patriotism of operators with their desire to buy the best on the market.

D. T. BEVAN.

London, W.11.

The First Aileron

I REGRET to say that both of your correspondents are wrong in their letters on the invention of the aileron. Any movable surface (hinged or otherwise) on the wing-tips came under the Wright patents filed in 1903 and issued in 1906. It was not until these patents were issued that the aileron came into use, which infringed the Wright patents, and caused numerous lawsuits in U.S.A. and Europe.

Southampton. L. HEATHER.

WITH reference to Mr. Gibbs-Smith's letter about ailerons, I have found three original photographs of Santos-Dumont's "14 bis," both just before and during its record flight at 4.45 p.m. on October 23rd, 1906, at Bagatelle, and these prove conclusively that there were, in fact, no ailerons of any description on the aircraft at all.

The two books of reference, both printed in 1909, also agree on the fact that the very first ailerons were used on Blériot's double-winged monoplane (the wings were in tandem, after Langley's machine). These ailerons were merely revolving wing-tips, as used on the Short Sherpa, on the front wing of Blériot's monoplane.

Glemsford, Suffolk. D. RODGER-BROWN.

FORTHCOMING EVENTS

Apr. 27. Society of Licensed Aircraft Engineers: "Aircraft Salvage Operations," by K. J. Anderson, A.M.S.L.A.E.
May 1. R.Ae.S.: Graduates and Students Section: "Some Thoughts on Present-day Aircraft and the Future," by Sir Frederick Handley Page, C.B.E.
May 2. Kronfeld Club: B.G.A. Slides.
May 3-4. Canadian Aeronautical Institute: A.G.M., Montreal.
May 3-5. Institute of Welding: Spring Meeting.
May 9. Kronfeld Club: "On Cumulus Clouds," by Dr. R. S. Scorer.
May 9. R.Ae.S.: All Day Section Lecture on Supersonic Flight. Speakers: A. V. Cleaver, F.R.Ae.S.; P. J. Duncton, B.Sc., D.I.C., A.F.R.Ae.S.; D. J. Farrar, M.A., A.F.R.Ae.S.; H. H. Gardner, B.Sc., F.R.Ae.S.
May 11. Helicopter Association: Film Show presented by G/C. R. N. Liptrot, C.B.E., B.A.
May 12. Surrey Flying Club: Anniversary Party.
May 12-14. Channel Islands Aero Club: International Rally.
May 15. R.Ae.S.: Section Lecture: "Medical Aspects of Flight Comfort and Efficiency," by Dr. A. Buchanan Barbour, O.B.E., M.R.C.S., L.R.C.P., F.R.Ae.S.
May 16. Institute of Navigation: "Ballooning," by C. H. Gibbs-Smith, D. N. Harrison, C. S. Durst.
May 16. Lympne Airport At Home.
May 16. Kronfeld Club: Film.
May 17. R.Ae.S.: The 44th Wilbur Wright Lecture: "The Aerodynamic Art," by Sir William S. Farren, C.B., M.B.E., F.R.S., F.R.Ae.S.
Sept. 3-9. S.B.A.C. Display, Farnborough.

R.Ae.S. Branch Fixtures (to May 28th):—

May 7, *Halton*, "Ejection Seats, the First Decade," by W/C. J. Jewell. May 9, *Weybridge*, A.G.M. May 11, *Birmingham*, Radar and Kindred Pilot Aids. May 14, *Halton*, Film. May 16, *Glasgow*, "Soaring Flight," by A. H. Yates. May 28, *Halton*, Film.

From a Very Young Reader

LOOKING through an old back number of *Flight*, I noticed you had printed a picture of a scale model of the Viscount turbojet airliner. I asked B.E.A. if they had any models they didn't want, and they very kindly sent me one of these models. I am very fond of air 'planes and wish to become a pilot some day.

My father has been ill now for five years and I cannot afford to buy model aircraft. It was very kind of B.E.A. to send it to me.

Stoke Aldermoor, Coventry. ROBIN W. SHIRLEY (aged 10½ years).

THE INDUSTRY

Dowty's "Nuclear" Establishment

ONE of the two photographs below shows the imposing headquarters of Dowty Nucleonics, Ltd., at Brockhampton Park, Andoversford, about eight miles from Cheltenham.

Dowty Nucleonics have had nearly eight years' experience in atomic energy instrumentation, and their activities include the development of various items of nuclear equipment now standardized for national plants. The company have acquired the fine 19th-century mansion to house their design and research departments. With its many acres of parkland on the fringe of the Cotswolds, it should provide an ideal location for this type of enterprise and for the team of about eighty specialists already working there under the direction of Mr. T. D. H. Andrews, A.M.C.T., A.M.I.Mech.E., A.F.R.Ae.S.

The electrical division of Dowty Equipment, Ltd., has lately been incorporated in Dowty Nucleonics, Ltd., and the design team at Royal House, Cheltenham, is moving to Brockhampton together with the sales and estimating departments and model shop. The factory at Tewkesbury, with its 200 employees, now becomes the production plant for Dowty Nucleonics.

Packaging Drop Tanks

IT is well known that Bristol Aircraft, Ltd., have for some time past been manufacturing plastic drop-tanks in a standard range of sizes from 50 gal to 500 gal capacity. They consist of a nose shell, centre section, and tail shell, which can be assembled in the field with simple hand tools.

An advantage of this method of construction is that the tank

The exterior of Brockhampton—and an interior scene, with parts of a jet-pipe-temperature test-rig under experimental development.

THE INDUSTRY . . .

components can be nested one within another for storage and transport. Export Packing Service, Ltd., of Sittingbourne, Kent, have recently been handling the packing of these tanks, and they have designed a light and strong case, within which a nested nose and centre section are compactly accommodated, and retained by bridge pieces. The tail section is held in place at the "nose" end of the box, and tail fins, where supplied, are clamped within the lid. This method demands only about two-thirds of the length which would be occupied by an assembled tank.

Canadian Bristol Directorship

THE Bristol Aeroplane Co. of Canada (1956), Ltd., has announced that its secretary, Mr. B. A. Chalmers, has been appointed a director and vice-president of the company's three subsidiaries, Bristol Aero Engines, Montreal; Bristol Aircraft (Western), Winnipeg; and Bristol Aero Engines (Western), Vancouver. He is also appointed a director and vice-president of the new Mexican subsidiary Bristol de Mexico, S.A. de C.V. Mr. Chalmers, who is a Scot and a graduate of Edinburgh University, joined the Bristol organization in Canada in 1954 as executive assistant to the president and was appointed secretary the same year. He originally qualified as a lawyer in Scotland and was subsequently called to the English Bar. From 1946 to 1954 he was engaged in university administration: he had been secretary and registrar of the University of Southampton from 1950. During the war, Mr. Chalmers served first in the Royal Artillery and later transferred to the Royal Air Force. He received his flying training in Canada and subsequently served as a fighter reconnaissance pilot.

Mr. B. A. Chalmers.

Dunlop control-column push-button switch (see below)

Control-column Switch Buttons

A RANGE of miniature electric switches to M.o.S. aircraft specifications has been developed by Dunlop's aviation division at Foleshill, Coventry. Primarily designed to meet the need to house several switches within the small compass of an aircraft control handle, the switches can also be supplied as single items.

The push-button switch shown has been approved for general aircraft duty at 2.0 amp (non-inductive) and 0.5 amp (inductive). It has been designed for rapid make and break and to give minimum contact resistance; contacts are of silver. A minimum life of 100,000 operations is proved for each of the two conditions: 2.0 amp, negligible inductance, at sea level; 2.0 amp, negligible inductance, at 60,000ft; 0.5 amp, inductive at sea level; 0.5 amp, inductive at 60,000ft.

Westminster Party

EACH year Elliott Brothers (London), Ltd., hold a party for their friends in the supply industries and they make a point of choosing a different and interesting venue on each occasion. This year, by courtesy of Capt. G. R. Chetwynd, M.P., they were able to use the Members' dining room of the House of Commons, where the 250-odd guests assembled, and were taken for conducted tours of the Palace of Westminster.

The Minister of Supply, Mr. Reginald Maudling, looked in on the party, which was attended by—it would be no exaggeration to say—more designers and test pilots than we remember seeing together at one time on any occasion other than the S.B.A.C. Show.

Elliott Brothers, whose H.Q. are at Lewisham, London, S.E.13, are designers and manufacturers of aircraft flight-control equipment and special-purpose instrumentation.

IN BRIEF

Desoutter Brothers (Holdings), Ltd., recently reported a 1955 group profit, after taxation, of £279,788 (1954, £228,321). United Kingdom taxation absorbed £270,180 (1954, £238,227).

* * *

Mr. W. W. Watt, who has been a managing director of The British Oxygen Company, Limited, since 1938, retired on March 31st, having reached the age of 65.

* * *

Titanine, Ltd., report a 1955 net profit of £83,001 (1954, £74,706) before taxation. At the a.g.m. on April 23rd the chairman, Admiral Sir Lionel Preston, reported a steady demand for Titanine finishes for both civil and military aircraft.

* * *

The directors of John Bull Rubber Co., Ltd., announce the retirement, this month, of Mr. John Cecil Burton, chairman and surviving founder-director of the company. He is 78. With his brother, Hubert Henry Burton, he founded the business as a two-man factoring concern in 1906.

* * *

Inspection Equipment, Ltd., 19 Broad Court, Drury Lane, London, W.C.2, have issued in brochure form a report on the discussions at the "Aircraft Radiography" meeting held in Copenhagen last December. Organized by Carl Drenck X-Ray Laboratories, the meeting attracted some 30 representatives from eight countries.

* * *

Mr. Alan E. Crawford, A.M.Brit., I.R.E., A.R.Ae.S., has recently joined the Brush Crystal Co., Ltd., at Hythe, Southampton, to take charge of a new research laboratory for the development and application of piezo-electric materials. The author of the recently published book *Ultrasonic Engineering*, he is well known for his work on industrial ultrasonics.

* * *

Taylor, Taylor and Hobson, Ltd., of Leicester, have this month celebrated their 70th anniversary, and have marked the occasion by the publication of a brochure entitled *Taly Ho—In Pursuit of Precision*. Among the modern products illustrated is the "Micro" alignment telescope, widely used in the aircraft industry. This remarkable instrument, it is stated, provides a means of establishing lines of sight, and the position of points in space, to an accuracy of plus or minus 0.001 in at a distance of 50ft.

* * *

James Booth and Co., Ltd., of Birmingham, have recorded a 1955 group profit, after all charges other than taxation, of £660,957 (1954, £336,800). Taxation, less over-provision in the previous year of £16,500 (1954, £26,431), absorbs £329,802 (1954, £137,083).

* * *

The United Steel Companies, Ltd., announce that Mr. S. R. Howes, at present director and general manager of Samuel Fox and Co., Ltd., of Stocksbridge, is to retire on June 30th. Mr. Howes, who will remain on the Samuel Fox Board, is to be succeeded by Mr. H. P. Forder, at present director and deputy general manager.

* * *

Mr. Charles W. Lane, who was until recently works manager of Airwork, Ltd., at Blackbushe, has joined Vickers-Armstrongs (Aircraft), Ltd. He is at the company's airfield at Wisley, where he is responsible for the engineering department handling flight testing and development of civil and military aircraft. Before joining Airwork in 1947, Mr. Lane was for many years with B.O.A.C.

* * *

We regret to learn of the death recently of Mr. Robert Anthony Harvey, B.Sc.(Eng.), M.I.E.F., a member of the engineering staff of Chloride Batteries Ltd., Mr. Harvey was responsible for technical activities in connection with Keepalite emergency lighting, battery control gear and allied equipment. He was well known as a lecturer at the Royal Technical College, Salford.

* * *

In a note on the many uses of "Titebond" adhesives, the manufacturers state that Titebond 22 is used in Rolls-Royce aero engines for bonding felt, Langite, and asbestos to metal surfaces. Applications of a similar kind are described and illustrated in a catalogue which, dealing with the full range of the company's industrial adhesives, is obtainable from Surridge's Patents, Ltd., at Elmers End, Beckenham, Kent.

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who would like to know more—and there's lots more to know—about Plessiflex should request Publication No. 808.

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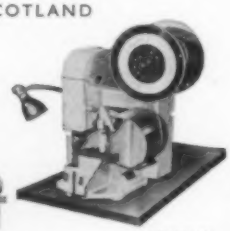


AP 323-10

CIVIL AVIATION

AFTER SIR MILES

IT would have been a miracle had the void left in B.O.A.C. by Sir Miles Thomas's resignation been filled to the satisfaction of everyone. Thus the appointments of Mr. Gerard d'Erlanger as the new chairman and Sir George Cribbett as his deputy inevitably brought the Minister of Transport and Civil Aviation, Mr. Harold Watkinson, under heavy Opposition fire, and in the Commons the exchanges were sharp.

The points raised at Westminster, and in other responsible quarters, are worthy of retrospective summary. It was, the Minister's critics said, a pity that B.O.A.C. should have had "its public status lowered" by the appointment of a part-time unpaid chairman. The changes had, it was argued, created an "organizational tangle": if there was inadequate work to merit a full-time chairman, what was the useful work that the full-time deputy chairman could do? To what extent would he encroach on the chief executive's field? To whom would the chief executive report—the deputy chairman or the chairman? Could it not be assumed from the appointment of a part-time unpaid chairman with a "professional civil servant" as his deputy, that the intention was to bring B.O.A.C. more tightly under Government control?

The Minister's answers were adroit, but clearly his critics are likely to remain unsilenced until time has proved whether or not their doubts are ill-founded. One remark made by Mr. Watkinson in reply to a newspaper's question about B.O.A.C.'s future equipment policy is worthy of quotation: "Nobody knows yet what the Boeing and Douglas are like—they have got an immense number of paper orders for paper aeroplanes." It is to be hoped that his new advisers will take a more realistic view of the challenge of the Boeing 707 and the DC-8.

Lord Rennell of Rodd has tendered his resignation from the position of part-time deputy chairman of B.O.A.C., and it is announced also that Lord Burghley, who has served B.O.A.C. for ten years, has been notified that his position as a part-time director, which terminated last month, will not be renewed.

Editorial comment on the new appointments appears on page 485. Brief biographical notes on Mr. d'Erlanger and Sir George Cribbett follow.

Mr. Gerard d'Erlanger, who is 49, learnt to fly in 1928, subsequently having flown about 60 types of aircraft. He became a director of Hillman Airways in 1934 and a director of British Airways, into which Hillman was merged, in 1935. Soon after British Airways and Imperial Airways joined to become B.O.A.C. in 1939 he became a director of the Corporation, remaining a member of the board until 1946. He founded the Air Transport Auxiliary just before the outbreak of war, and was its commanding officer until the end of hostilities, being responsible for the delivery of some 350,000 Service aircraft. In 1946 Mr. d'Erlanger helped to found B.E.A., becoming its first managing director and subsequently its chairman—a position which he held until 1949. He was appointed to the Air Transport Advisory Council in 1952, becoming its deputy chairman in 1954. In 1953 his firm, Erlangers Ltd., combined with other interests to form Air Finance Ltd. to assist financing the export of British aircraft. He became a chartered accountant in 1933 and was a member of the Stock Exchange from 1935-1939.

Mr. Gerard d'Erlanger, C.B.E.

Sir George Cribbett, K.C.B., C.M.G.

Sir George Cribbett was appointed deputy secretary to the Ministry of Civil Aviation in 1946. In that Ministry and subsequently in the Ministry of Transport and Civil Aviation he was associated with the Corporations, being mainly responsible for negotiating international traffic rights on their behalf. Sir George, who is 60, served as a pilot in the R.A.F. in the 1914-18 War. He joined the Exchequer and Audit Department in 1919 and at the beginning of the Second World War was a principal in the Air Ministry. From 1941 to 1943 he was director of administration and finance with the R.A.F. in Washington, and on his return from the United States in 1943 assisted in the formulation of post-war British international air policy and the organization of its air transport. He was a delegate under Lord Swinton at the Chicago Conference of 1944, which set up I.C.A.O., since when he has attended numerous Commonwealth and international conferences on civil aviation as the leading U.K. delegate. In 1948 and 1949 he was associated with Sir Miles Thomas in reviewing B.O.A.C.'s organization. In 1950 he delivered the Sixth Commonwealth and Empire Lecture, "Some International Aspects of Air Transport."

AIR TRANSPORT AT OXFORD

THE success of the Royal Aeronautical Society's two-week air transport course at Christ Church, Oxford, which ended on April 18th, was evident in the atmosphere at a farewell dinner held in Hall the previous evening. Present were the 33 students attending the course, the organizers and lecturers, and a number of guests engaged in the administrative, legal, manufacturing and operating spheres of air transport.

The students of the course comprised representatives of B.E.A., Aer Lingus, Iceland Airways, El Al, National Greek Airlines, K.L.M., Hunting-Clan, Airwork, Air Vietnam, Pan American, Blackburn and General Aircraft, British Petroleum, Vickers-Armstrongs, Shell Petroleum, Handley Page, Bristol Aircraft, Bristol Aero Engines and Armstrong Whitworth. Particularly large was the representation of Iceland Airways, who sent a contingent of six.

During the fortnight at Oxford the students had attended morning lectures on air-transport economics, operations, and law, with group discussions and case studies in the afternoons, and had heard a number of evening guest speakers.

Under Dr. E. W. C. Wilkins, M.A., B.Sc., Ph.D., assistant director of the course, the resident lecturing staff consisted of Mr. S. F. Wheatcroft, B.Sc. (economics), Mr. K. G. Wilkinson, B.Sc., D.I.C. (operations) and Mr. A. R. Barrowclough, B.A. (law). Dr. A. M. Ballantyne, B.Sc., Ph.D., secretary of the Society, was director of the course.

At the dinner, the toast of "Air Transport" was proposed by Mr. N. E. Rowe, C.B.E., president of the Royal Aeronautical Society. Air transport was a dynamic addition to the social pattern of life, he said, and it was appropriate that the first such course in the subject should be held in Oxford, where academic calm had consistently produced dynamic ideas. The course had been a modest start, but a successful one, and there was every likelihood that a similar course would be held next year. It was indeed hoped to make the course an annual event, perhaps followed by the establishment of a University chair of air transport.

The response was made by Sir Frederick Tymms, K.C.I.E., M.C., formerly U.K. representative on the Council of I.C.A.O., who traced in detail the history of that organization.

The health of the guests and of Christ Church was proposed by Dr. Ballantyne, and Mr. S. N. Grant-Bailey, a Student of Christ Church and Dean of the Law Faculty at Southampton University, replied. Speaking on behalf of the students of the air transport course, Mr. A. G. L. Langfield, of Bristol Aircraft, Ltd., stressed the benefits of belonging to such an international study group, and of the resulting interchange of ideas between the manufacturing and operating sides.

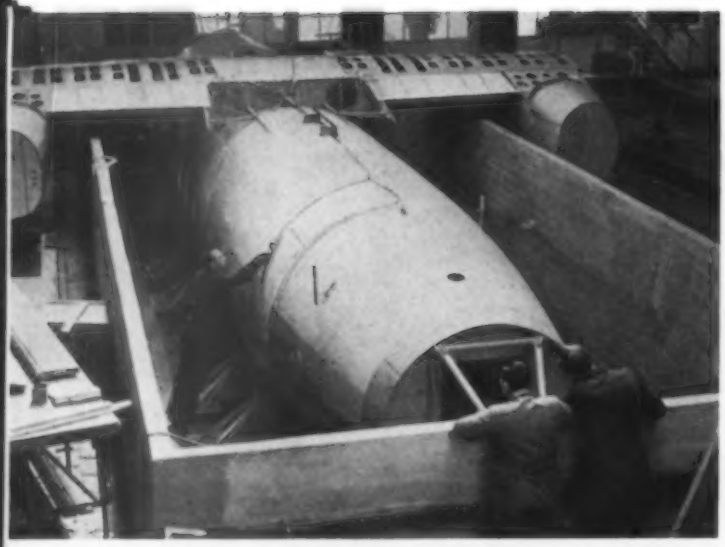
ELECTRAS FOR WESTERN

A FLEET of nine Lockheed Electras, to be powered by Allison 501 turboprops, was ordered last week by Western Airlines, one of the "Middle Six" U.S. domestic airlines. The aircraft will be delivered between the end of 1959 and the spring of 1960, and will cost £7m with spares. This is Western's first association with Lockheed; the airline's present fleet comprises eight DC-6Bs (plus 13 on order), nine Convair 240s, six DC-4s and eight DC-3s. The route network of 5,525 miles stretches from Edmonton, Canada, in the north to San Diego, California, in the south.

The number of Electras for which firm orders have now been placed amounts to 128, distributed as follows: American, 35; Eastern, 40; Braniff, 9; National, 23 (increased from 20); K.L.M., 12; Western, 9.

MORE FRIENDSHIPS FOR THE U.S.

A FIRM order for six Fokker Friendships has been placed by Frontier Airlines, Inc., a small local service airline of Denver, Colorado. Frontier operate 13 DC-3s over a route network of about 3,500 miles (average stage length: 100 miles). They are the third United States operator to have ordered the aircraft, which, like those for West Coast Airlines and Mackey Airlines, will be built under licence to Fokker by Fairchild of Hagerstown.



(Left). The second Fokker Friendship being prepared "to go under-water" for pressure-testing. (Below). A new picture of the Eland Airliner, Napier's Convair 340 conversion. A news item below announces the establishment of an Eland agency in the U.S.A.

CIVIL AVIATION . . .

A DECADE OF I.A.T.A.

FOUR members of the staff of I.A.T.A. who have served the international airline organization during the whole of its post-war career have just been honoured in Montreal by I.A.T.A.'s director general, Sir William Hildred. The four are: Dr. Henry J. Gorecki, treasurer and financial director; Mr. Stanislaw Krzyczkowski, technical director; Mr. H. Tandy Davoud, assistant to the financial director; and Miss Jean Telfer, Sir William's private secretary.

PROMOTING THE ELAND IN THE U.S.A.

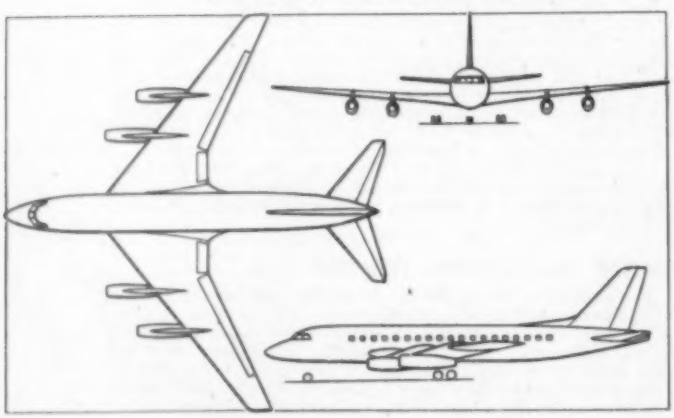
PLANS for marketing the Eland in the United States have just been concluded between the Napier company and the Aircraft Supply Company of Washington, D.C. At the same time comes news that Napier are promoting the idea of converting not only the Convair 340 to Eland power: full engineering studies have now been made for the similar modification of the DC-6 and the Martin 4-0-4. Both these aircraft, like the Convair 340 (of which Napier have had an Eland conversion flying since February), have similar Pratt and Whitney R-2800 powerplant installations.

Napier's commercial enterprise in producing a specimen Convair Eland-conversion is thus taken several steps further, and the setting up in the U.S.A. of a native sales agency is a sign of the big effort being put into the forthcoming demonstration tour over there. The price of a Convair Eland conversion, incidentally, estimated in our description of February 3rd as likely to be £125,000, is now understood to be of the order of £107,000. With allowance for the cost of engine maintenance the improvement in performance, it is calculated, increases the hourly revenue earning by more than £28 on short-hauls, with correspondingly greater revenue as stage lengths increase.

CONVAIR SKYLARK 600

REPRODUCED below is a general arrangement drawing of the Convair Model 22 Skylark 600. Here also is a summary of the technical data so far made available about the aircraft, of which an artist's impression and a Comet-comparison have appeared in previous issues. Powerplant: Four General Electric CJ-805 (commercial J79) of 10,000 lb static drive thrust each; span, 118ft 4in; length, 118ft 5in; wing area, 2,000 sq ft; sweep back, 35 deg; gross weight, 170,000 lb; payload (80 passengers), 19,700 lb (99 passengers), 22,835 lb; zero fuel weight, 100,000 lb; max. landing weight, 115,000 lb; operating weight empty, 72,600 lb; fuel capacity, 70,000 lb; typical stage length (19,700 lb payload and reserves for 50 m.p.h. headwind, 200 mile diversion, and one hour's holding at 20,000ft), 1,750 st. miles; normal cruising speed 580 m.p.h.; direct operating cost per seat mile, 2.4 cents (200 miles), 1.15 cents (1,500 miles); take-off distance to 50ft at gross weight, 6,700ft; landing distance (without reverse thrust), 5,000ft maximum; approximate price, £1.18m.

General arrangement of the Convair Skylark 600.



BOEING REPLIES

IT was to be expected that the recent article "Atlantic Airline Costs" in the *Manchester Guardian* (commented upon in *Flight* for March 9th) should have stung the Americans into making a reply. In a lengthy letter published in the newspaper's issue for April 11th, Mr. Wellwood Beall, Boeing's senior vice-president, makes some points which should dispel current delusions in certain quarters that the new American jet airliners are not really a very serious challenge. "The performance Boeing quotes for its 707 Stratoliner and 707 Intercontinental is *guaranteed* and specified in the purchase contracts. We cannot conceive that anyone would honestly believe businessmen responsible for their actions to stock-holders and financial backers would be so rash as to order pigs in pokes . . . We have never considered the six-engine, 330,000 lb airplane mentioned in the article . . . We would not risk the reputation we have built up in forty years or hazard our company's future by ill advisedly signing a contract with an airline to produce a transport with certain specified characteristics and capabilities without being very sure that we could produce that air transport . . . None of our customers 'reluctantly signed'. . . There will be other customers in the future and I dare say some of them will fly the flag of the British Commonwealth."

IRAQI VISCOUNT'S LONDON DEBUT

ON Monday of last week Viscount YI-ACK *Ibn Firnas* flew into London Airport from Baghdad on the inaugural service between these two cities. The operation will be on a once-weekly-return basis at first, flying by way of Istanbul and Vienna and carrying 36 passengers on a first-class ticket. When Iraqi Airways receive their fourth Viscount later this year the airline will extend its operations eastwards from Baghdad to Karachi and Bombay, thus providing a Viscount link between the United Kingdom and India and Pakistan.

DC-8 ECONOMY

"THE Versatile Jet Transport" was the title of a paper read before the Society of Automotive Engineers on April 11th by Douglas aerodynamicist Mr. Richard S. Shevell. The paper contained references to the operating cost of the DC-8, a subject about which little official information is being released. For a range of 1,000 n.m. the domestic J57 (JT3) version has, it was stated, a 22

This Ercoupe which flew from Belgium to New Zealand in 22 days in 1947, and which was later declared a write-off after a crash in New Zealand, has been restored (in his own backyard) by Mr. G. N. Wells, Auckland station manager of Tasman Empire Airways.

per cent advantage in direct operating cost over the DC-6B. This assumed a 118 passenger DC-8 carrying 32,970 lb payload and a 58 passenger DC-6B carrying 15,100 lb payload.

The DC-6B, one of the cheapest of all transports to operate, has a direct seat-mile cost in its first-class version of about 1½ cents over a comparable distance.

"These data show," said the lecturer, "that where the passenger traffic will justify an airplane the size of the DC-8, a large jet transport can be economically operated over almost any existing airline route." Explaining that the economic penalty of operating at lower altitudes was "relatively small," Mr. Shevell said that at 400 n.m. range cost is increased only seven per cent by flying at 20,000ft instead of at 35,000ft.

EAGLE APPOINTMENTS

SINCE last week's civil aviation issue of *Flight* closed for press, some new appointments have been announced by Eagle Aviation. Maj. Gen. C. G. D. Greaves, C.B., C.B.E., formerly a director, becomes deputy chairman under Mr. H. Bamburg (chairman and managing director). Mr. Geoffrey W. Pitt, until now commercial manager, becomes a director of the company, his particular responsibility being for the company's charter activities. Capt. J. H. Sauvage, D.S.O., D.F.C., also is appointed a director; he will continue to be in charge of operations. Mr. Bill Rodger becomes general manager of Eagle Airways.

BREVITIES

THE fact that Philippine Air Lines has placed an order for two Viscount 770Ds (standard North American version of the 700D) is now officially confirmed. The order brings Viscount sales to 304, P.A.L. being the twenty-seventh airline to purchase the Viscount.

* * *

The first flight of the Aviation Traders' Accountant is scheduled for August.

* * *

Helicopter problems will be discussed at San Remo by I.A.T.A.'s technical committee on May 3rd and 4th.

* * *

Air transportation valued at nearly £78m was produced and sold by T.W.A. in 1955—7 per cent more than in the previous year. More than four million passengers were flown.

A proposal to form a company to run Ceylon's internal air services has been put forward by a group of Ceylonese businessmen, based on the Scottish Aviation Twin Pioneer.

* * *

The retirement on June 30th of W/C. W. R. Parkhouse who, except for a period during the war, has been manager of Exeter Airport since 1938, is announced. His successor will be W/C. R. J. B. Pearse, at present managing director of Plymouth Airport.

* * *

Seaboard and Western Airlines assumed active membership of the International Air Transport Association with the inauguration on April 10th of its scheduled all-cargo service across the North Atlantic. Seaboard has made B.O.A.C. its sales agent in the United Kingdom.

CLUB AND GLIDING NEWS

FRESH, bright weather and 33 visiting aircraft attended the Elstree Flying Club's tea patrol on Sunday last, April 22nd. Eleven of the attackers were spotted by the defending patrol, which included guest defender F-PHFR, the blue Druine Turbulent flown by Harold Best-Devereux. Among the airborne visitors were Gipsy Moth G-ABJJ, Spartan Arrow G-ABWP, and a trio from Baginton including the gold Gemini of Percy Blamire. Even more determined groundborne visitors were a fine crop of this season's young spotters (notebooks, binoculars and cameras at the ready) from the other side of the wire fence bounding Elstree's new reservoir.

A second works flying club—that of Bristol Aircraft's London office—has begun operations at Elstree where, for the past two years, the Handley Page club has been flying. A new full-time instructor, Ken Howard, is joining the staff of the Elstree club, who for the spring and summer season will be operating with four full-time and four part-time instructors.

A NATIONAL air rally is being planned by the Popular Flying Association, to take place at Shoreham Airport over the week-end of June 16th-17th. This will be the first since 1951, and will mark the tenth year of the Association's existence. A great expansion in P.F.A. group activity has taken place during the last twelve months, the total number of affiliated groups now approaching 50. New groups listed in the current issue of *Popular Flying*, the P.F.A. bulletin, are at Southport, Thruxton, North Norfolk and Walney Island, Barrow-in-Furness; while the Home Counties, Thorney Island, Leicestershire and Southampton groups have now disbanded.

THE SCOTTISH AERO CLUB is the name of the new club which, operating from Perth Aerodrome, has absorbed members of the Strathtay Aero Club and the Scottish Flying Club. The latter club recently ceased operations at Renfrew.

PLYMOUTH AERO CLUB have challenged Exeter Aero Club to defend their aerodrome against invaders on the morning of Sunday next, April 29th. Time of the breakfast patrol at Exeter is 8.30 to 9.30 a.m., approach height between 1,200 and 3,500ft. Recent competition winners at Plymouth include M. McDermott (spot landing) and M. Armstrong (Butler navigation trophy).

AT the annual dinner-dance of the London Gliding Club held at Dunstable on Saturday, April 14th, 1956, the main speakers were John Simpson, John Furlong, Frank Foster, Miss Valerie Crown, F. N. Slingsby, and Dan Smith. A model of a Sky was presented to A. Walker, vice-president, for his quarter of a century's service to the club. Also presented were a £10 cheque (given by the late Capt. A. G. Lamplugh) for the first "Gold C" from Dunstable, and the Dent Cup for the most meritorious flight in 1955, to Frank Foster; the Cellon Cup for the best 1955 *ab initio* to L. Collins; the Derry Trophy for the most work for the club, to the Transport sub-committee as a whole; and the Desoutter Cup for the best constructional effort in 1955 to A. Doughty.

R.Ae.C. PILOTS' CERTIFICATES, JANUARY-MARCH, 1956

No.	Name	Cl.	Date	No.	Name	Cl.	Date
28,732	B. J. Hazlewood	3	3/1/56	28,741	C. O. B. M. Byrte	3	26/1/56
28,733	R. Sutcliffe	3	3/1/56	28,742	A. C. Wilson	4	9/2/56
28,734	C. T. Oman	2	3/1/56	28,743	E. Crabtree	2	17/2/56
28,735	F. D. Weston	4	10/1/56	28,744	S. N. B. Craft	2	22/2/56
28,736	J. A. Pothecary	1	10/1/56	28,745	C. H. Croxson	4	8/3/56
28,737	M. C. Barraclough	2	16/1/56	28,746	W. H. Tucker	1	20/3/56
				28,747	G. A. Walker	1	20/3/56
28,738	P. V. Lovett-Campbell	2	16/1/56	28,748	W. L. Hey	2	21/3/56
28,739	D. F. Edminson	4	17/1/56	28,749	A. G. W. Belcher	3	27/3/56
28,740	T. S. Syme	2	26/1/56	28,750	I. C. R. McIntosh	3	29/3/56

SERVICE AVIATION

Royal Air Force and Fleet Air Arm News

Libya's ruler, King Idris El Senussi, accompanied by W/C. D. M. H. Craven, Station Commander at El Adem, inspects the ceremonial parade which marked his visit to the station on April 11th. He watched formation aerobatics by No. 208 Sqn. Meteor F.R.9s and rocket firing by Venoms of No. 73 Sqn.

Trophy Winners

THE Dacre Trophy for the day fighter squadron achieving the best results in air gunnery has been won by No. 64 Sqn., based at R.A.F. Duxford, for the period 1954-1955. The trophy was presented to the Commanding Officer, S/L. J. Garden, last Friday.

The Duncan Trophy, 2nd T.A.F.'s award for proficiency in air firing has been won by No. 87 Sqn. based at Wahn, Germany. No. 87 Sqn. flies Meteor N.F.11s and is the first night fighter squadron ever to win the award. The trophy was originally presented to the R.A.F. by Gen. Gervasio Duncan, then Chief of Staff of the Brazilian Air Force, when he visited R.A.F. units in 1947. It was presented to No. 87 Sqn. on April 13th by Air Marshal the Earl of Bandon, A.O.C.-in-C. 2nd T.A.F. No. 87 Sqn. is commanded by W/C. L. W. G. Gill.

Freedom of Aylesbury

NEXT Tuesday R.A.F. Halton is to receive the freedom of Aylesbury at a large parade. More than 600 of the station personnel are to march through the town with colours flying, bayonets fixed and bands playing, and the Commanding Officer, A. Cdre. G. N. E. Tindall-Carill-Worsley, will receive the Deed of Freedom in a casket from the mayor, Councillor W. Fewkes.

The parade will include squads from all six units based at Halton and the Apprentices' pipe band will be led by their goat mascot, Cpl. Lewis III. The Queen's Colour for the R.A.F. in the United Kingdom and the Queen's Colour of No. 1 School of Technical Training will be paraded.

Canal Zone Evacuation

THE last airfield to be operated by the R.A.F. in the Suez Canal Zone, Abu Sueir, was evacuated on April 14th. This completed the R.A.F.'s withdrawal from all airfields and their supporting installations, but a small party was left at Port Said to supervise the last transit movements. Abu Sueir was formally handed over to the Egyptians.

"Medflex Dragon" Completed

THE major NATO sea/air exercise, called "Medflex Dragon," the largest yet held in the area, ended on April 20th. The main operations were convoy protection. Canberras from Binbrook, Lincs, and Neptunes from Topcliffe, Yorks, went to the Mediterranean to fly with other NATO aircraft. The R.A.F. Neptunes operated from Gibraltar with Shackletons and Portuguese Harpoons.

The exercise ended with a steam-past and fly-past off Ma'ta Grand Harbour on April 20th when 50 allied ships, in two eight-mile-long lines, passed the dispatch vessel *Surprise* in which was Gen. Gruenther, the retiring SACEUR. The fly-past of some 70 allied aircraft was led by Air Marshal G. E. Nicholetts, A.O.C. Air H.Q. Malta, flying a Meteor 7 of No. 39 Sqn. Following him were French torpedo bombers, Neptunes and Aquilons, Italian Harpoons, Vampires and Mustangs, U.S. Navy Neptunes and R.A.F. Shackletons, Meteors, Venoms and Canberras.

The U.S. Navy Neptunes operated from an advanced base in southern Sardinia and were supported there by an advanced base support ship, the L.S.T. *Alameda County*.

Malayan Air Supply

DROPPING supplies to forces operating in the Malayan jungle is to become the responsibility of No. 41 Sqn. R.N.Z.A.F. The squadron's Bristol Freighters have moved up to Kuala Lumpur to begin operations.

Atlantic Exercise

AIR and naval units of the U.S.A., Canada and Great Britain will take part in a six-day NATO anti-submarine exercise in the Atlantic. Called "New Broom V," the exercise will begin on May 1st with the sailing of a convoy from Norfolk, Virginia, to Gibraltar. Hunter/killer groups will protect the convoy from submarines. Operations will be controlled by NATO commanders.

Senior Appointments

THE Air Ministry announces the appointment of A. Cdre. D. J. P. Lee as secretary of the Chiefs of Staff Committee and of A. Cdre. G. F. A. Skelton as Air Attaché in Bonn, Western Germany.

A. Cdre. Lee formerly commanded R.A.F. Scampton. During the early part of World War 2 he was with Hampden squadrons operating against German naval targets. He then served two tours of duty at the Air Ministry and, in May 1945, commanded No. 904 Wing, flying Thunderbolts in India and Java. In 1950 he became Deputy Director of Air Staff Policy.

A. Cdre. Skelton joined the R.A.F. in 1930, flew fighters and bombers and served as a test pilot at Martlesham Heath before being shot down in a Defiant and taken prisoner in May 1940. He was repatriated in 1943 and, in 1946, commanded No. 51 Sqn., Transport Command. In 1949-50 he was Air Attaché in Prague and for the past two years has been Command Intelligence Officer at H.Q. 2nd T.A.F.

Royal Iraqi Air Force

NOW operating Vampires and Venoms and modern training aircraft, the Royal Iraqi Air Force is 25 years old. It was formed when five D.H. Gipsy Moths, flown by Iraqi pilots, arrived at Baghdad on April 22nd, 1931. About 30 skilled R.A.F. officers and airmen are seconded to give advice on tactical and technical matters and G/C. P. W. D. Heal is Air Advisor to H.M. King Feisal. Iraqi personnel attend courses in Britain. Under treaty agreements the bases formerly operated by the R.A.F. have been handed over to Iraq and R.I.A.F. personnel will operate all traffic control facilities as soon as they have gained sufficient experience to deal with the wide variety and intensity of traffic.

Good Shooting

FOR the tenth year in succession the R.A.F. has won the inter-Services rifle match promoted by the National Small Bore Rifle Association. Their score of 7,950 points out of a possible 8,000 is a new record, and also breaks the scoring record for the fourth year in succession. Runners-up were again the territorial army, with 7,927 points. Regular Army, R.N., R.M. and R.N.V.R. teams also competed.

R.A.F. Sailing

THE R.A.F. Sailing Association's championship meeting for 1956 will be held at the Welsh Harp, Hendon, from October 3rd to 7th. Trials for the selection of teams for the inter-Services meeting in July will take place at Seaview on June 20th and 21st. Agreement has been reached with the Army and Navy for the holding of an annual inter-Service dinghy meeting. The R.A.F. will be host for the first meeting, to be contested by Fireflies at the Welsh Harp early in October.

Medical History

THE second volume of *Royal Air Force Medical Services*, edited by S/L. S. C. Rexford-Welch, has been published by H.M. Stationery Office. Its price is £3 15s. The work deals with many aspects of the aeromedical research carried out in the Service during World War 2, including the development of night vision, the investigation of aircrew efficiency, "flying doctors" in Bomber Command, prevention of suffering from cold during transatlantic ferry flights, blood transfusions, parachute training and the beginning of the R.A.F.'s mountain rescue teams. The work of individual R.A.F. medical officers in many theatres of war and in many curious circumstances gives the work a particular interest.

Reunions

THE annual reunion of No. 619 Sqn. is to be held in the "Magpie and Stump," 18 Old Bailey, London, E.C.4, on May 12th. Details from P. S. Osborne, A. R. Heathcote and Co., Ltd., Bernard Works, Sylvester Gardens, Sheffield 1.

No. 43 (F) Sqn. is holding an all-ranks annual reunion dinner at the Paviour's Arms, Page Street, Westminster, tomorrow. Details from J. Beedle, 69, Ox Lane, Harpenden, Herts.

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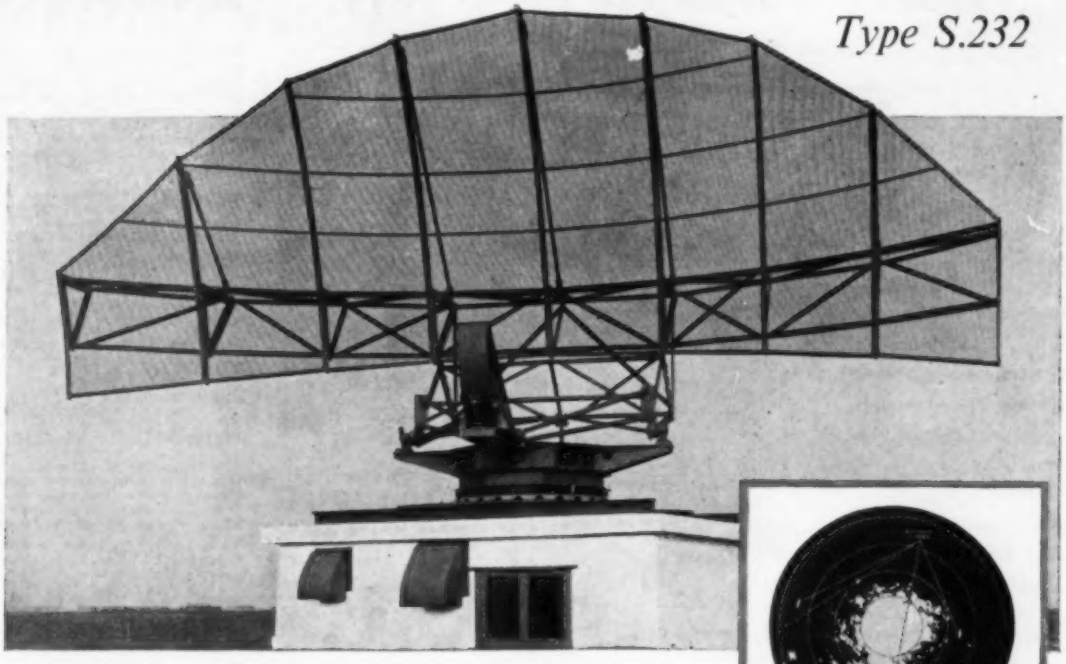

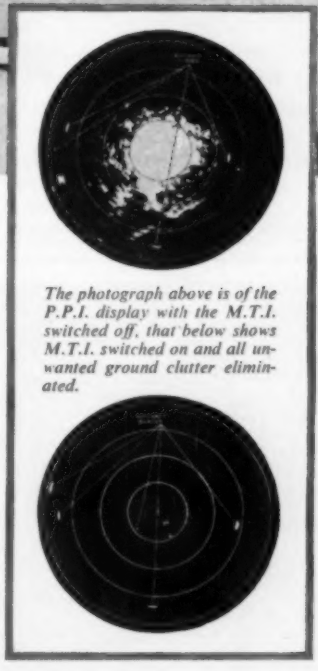

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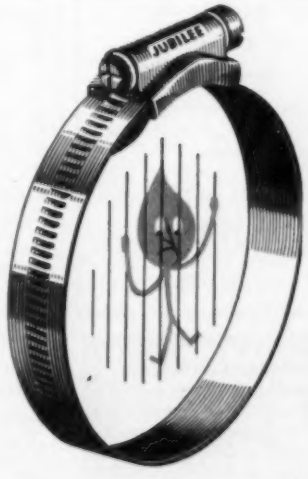

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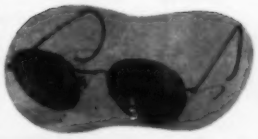

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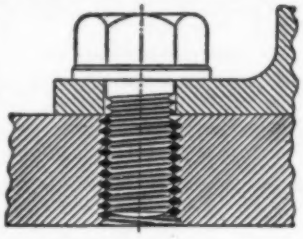

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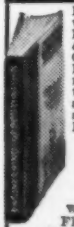

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THESE applications will be considered by the Council under the Terms of Reference issued to them by the Minister of Civil Aviation on 30th July, 1952. Any representations or objections with regard to these applications must be made in writing stating the reasons and must reach the Council within 14 days of the date of this advertisement, addressed to the Secretary, Air Transport Advisory Council, 3, Dean's Yard, London, S.W.1, from whom further details of the applications may be obtained. When an objection is made to an application by another air transport company on the grounds that they are applying to operate the route or part of route in question, their application, if not already submitted to the Council, should reach them within the period allowed for the making of representations or objections. [5154

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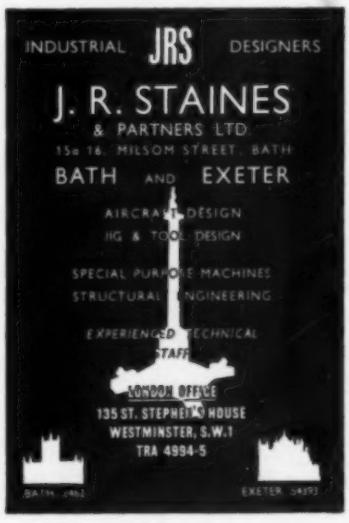

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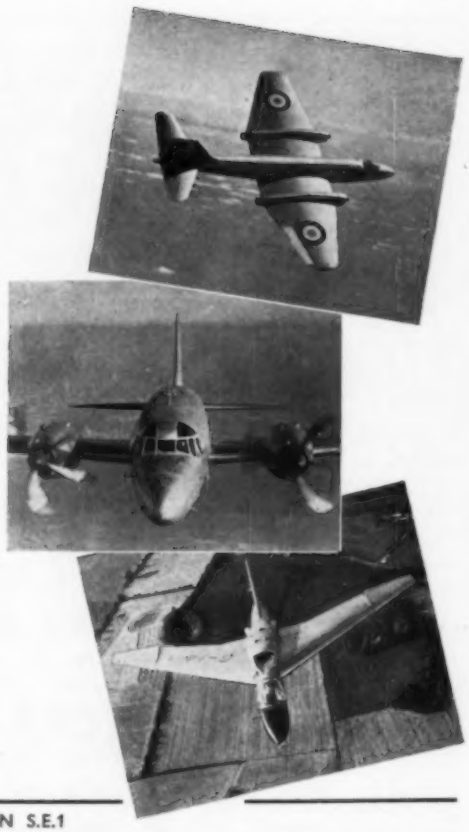

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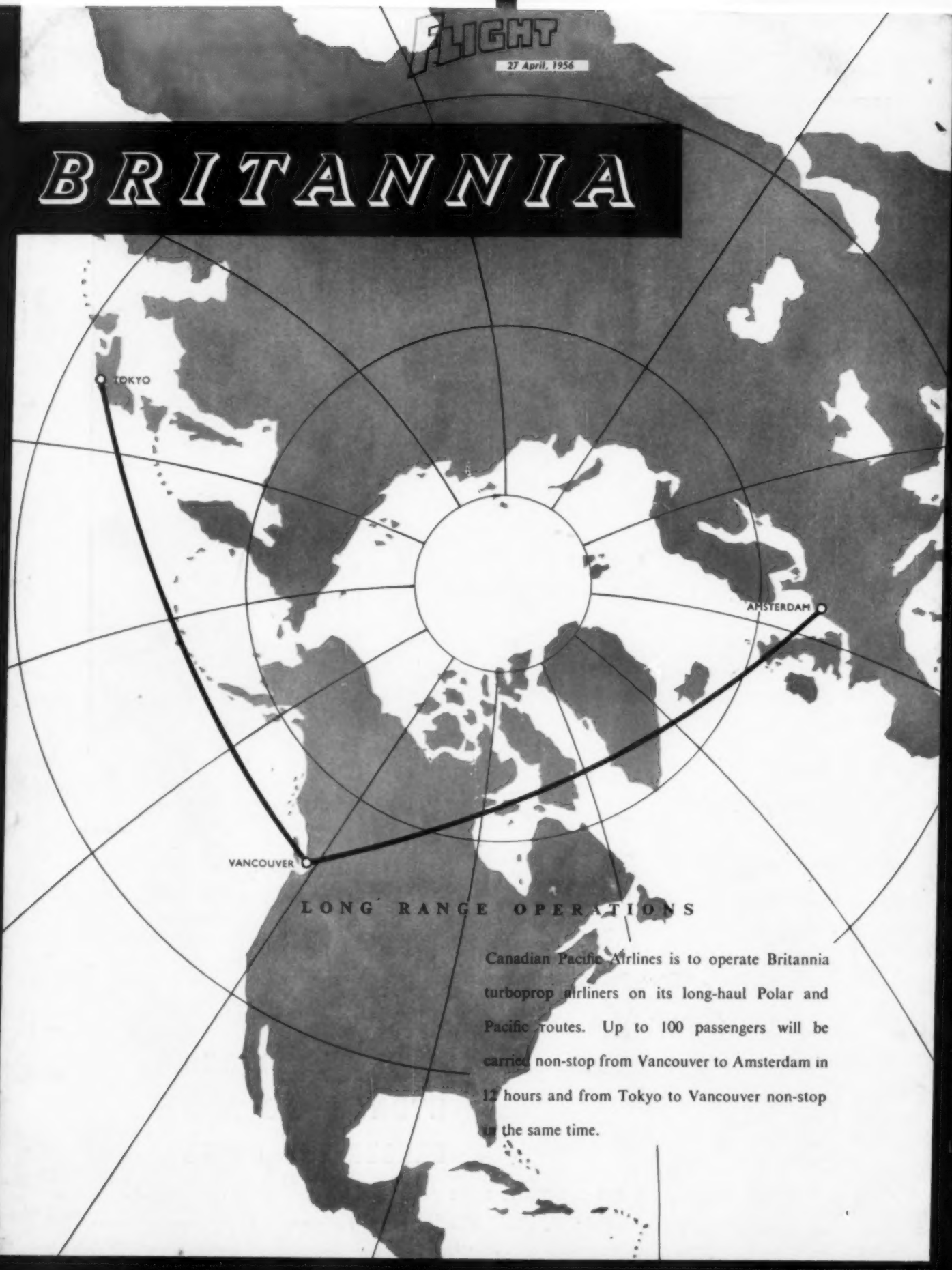

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